Testing the Waters:

Factors that Influence Water Conservation and Efficiency in the Santa Clara Valley Water District

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EXECUTIVE SUMMARY

Faced with severe drought and one of the state's fastest growing regions, Santa Clara County (SCC) must devise a set of strategies to meet future water demand. One of these strategies is to ensure that water is used in a more efficient way through conservation and efficiency measures. For the past few decades, SCC's sole water wholesaler, Santa Clara Valley Water District (SCVWD), has been actively working with their thirteen independent water retailers to encourage water conservation. In collaboration with SCVWD, our team conducted a comprehensive evaluation of their water conservation and efficiency programs to arrive at a set of recommendations to meet their long-term conservation goals.

This study explored the following research questions:

- What factors influence water conservation and efficiency in SCVWD?
- What have been trends in program participation by retailer over the last twenty years?
- Which programs are most cost-effective, have the largest per capita impact on water use, and can best be scaled to reach large segments of the district customer base?
- What recommendations emerge from this study to best improve water conservation and efficiency in the future?

We evaluated ten of SCVWD's conservation programs to determine participation across thirteen retailers, identify trends in water savings, and evaluate each program by cost-effectiveness, impact, and scale. We created a ranking system based on current and potential savings. From our retailer analysis, we found that smaller and medium sized retailers in SCVWD perform better than larger metropolitan retailers when it comes to proportion of community engagement.

As part of our study, we compared residential, commercial, and landscape programs using the following criteria: **cost-effectiveness, impact,** and **scale**. We found that the Residential Showerhead program has been the most cost-effective program. For impact, our data indicates that the Residential Clothes Washers excels. Of the SCVWD's residential programs, the Residential High Efficiency Toilet (HET) program has the most potential to be scaled; currently only 2.55% of District residents have participated in this program. Overall, the best three district programs are the Residential Showerhead, Residential High Efficiency Toilet, and Residential Clothes Washer programs, in that order.

We also conducted a best practices analysis by observing the systems in place for San Francisco Public Utilities Commission (SFPUC), Municipal Water District of Orange County (MWDOC), and East Bay Municipal Utilities District (EBMUD). We found that, like SCVWD, peer water district wholesalers like SFPUC, MWDOC, and EBMUD have innovative water-savings programs that both holistically engage their respective populations and create cultures of water conservation and efficiency. Geographic and demographic factors make direct comparisons with

peer water districts difficult at best, but from our research, we learned that all three observed benefits from the automated water meter systems that track household water savings and provide households tailored suggestions to reduce water use.

Our team advanced two alternatives, “expanding the tent” and “changing social norms,” as the two most palatable interventions in the short and long term.

1. “Expanding the tent” is a strategy of reaching out to specific demographic groups and locales, which have comparatively low rates of participation and engagement around water conservation and efficiency. As more SCC citizens participate, retailers can develop economies of scale and more cost-effectively run passive and active programs. “Expanding the tent” naturally increases programs’ impact, as participation rates increase across the district. While programs might lose their potential for scale as more residents participate, the proportion of the population engaged increases.
2. “Changing Social Norms” can help cultivate to a community of expectations around active participation in water conservation and efficiency. Such norms will allow greater participation in rebates and incentive programs regardless of the cost. They will also lead to higher impact numbers across the board as citizens engage due to a common understanding of the importance of water use. Much like in “Expanding the tent,” changing social norms will lead to an increase in the proportion of SCC households reached.

Alternative efforts such as “expanding the tent” and “changing social norms” will complement the tremendous work of Santa Clara Valley Water District. As population continues to increase in Silicon Valley, water conservation and efficiency programs must similarly grow to reach new demographics and change behavior in new ways.

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1. INTRODUCTION

The Santa Clara region has seen significant growth over the last 50 years, and more growth is to be expected. In 1960, only 640,000 people called Santa Clara County their home, and it has now grown to nearly 2 million people today.[1] In fact, Santa Clara's population has grown by another 5% just over the last five years.[2] One of the main contributors to the population growth has been the rise of the Silicon Valley, which lies within the boundaries of Santa Clara County. The booming technology industry and abundance of skilled workers have drawn large companies like Google, Facebook, Ebay, Apple and Oracle to the area.[3] Reliable access to clean water is key in order to maintain current and future growth in the region as a whole.

The Santa Clara Valley Water District (SCVWD) is the main water wholesaler for Santa Clara County and its 1.8 million residents.[4] SCVWD distributes water to thirteen water retailers including San Jose Water Company, San Jose Municipal Water System, Purissima Hills Water District, Stanford Utilities, and the Cities of Palo Alto, Mountain View, and Sunnyvale. The SCVWD's mission is "to provide Silicon Valley safe, clean water for a healthy life, environment, and economy."[5] With over a half a billion-dollar budget, SCVWD serves as a vital economic player in the Santa Clara region.

The SCVWD has pioneered successful conservation and efficiency programs to reduce urban water usage in order to meet future demand even before the escalation of current drought conditions. However, severity of the current drought has shone a spotlight on the increasing need for more effective water conservation and efficiency programs.[6] According to the San Jose Weather station, Santa Clara averages 15.08 inches of precipitation a year.[7] Over the last three years, San Jose has only received a total of 22.83 inches (7.6 in. per year).[8] This amounts to less than half the yearly average.

The goal of this project was to identify which of SCVWD's conservation and efficiency programs have most effectively decreased water use in the past twenty years. Our team put forward the following research question: "What are the factors that influence water conservation in the Santa Clara Valley Water District, and what active conservation programs will most effectively shape future water conservation?"

We began by narrowing our analysis down to ten active programs based on available data and impact criteria. We then considered the current efficacy of water conservation programs in the district for a cross-section of district residents. Following this, we carried out calculations to determine the cost-efficiency, impact, and scale of each program. Using these results we evaluated alternatives and considered potential recommendations and next steps to improve water conservation in the area. In order to provide a comprehensive outlook on future possibilities SCVWD can take, we conducted a best practices analysis relating Santa Clara Valley Water District to other California water districts, namely the San Francisco Municipal Utilities Commission and the Municipal Water District of Orange County. All things considered, we concluded that SCVWD should invest in efforts to expand the tent and change the social norm around water use.

2. DEMOGRAPHIC ANALYSIS OF SANTA CLARA COUNTY

Santa Clara Valley Water District is the sole water retailer for Santa Clara County. Of the district's thirteen water retailers some are geographically isomorphic to specific municipalities and others are not. (Please see Table 3 for a list of the district's thirteen retailers). In the past decade, the county has grown rapidly. Demographic trends highlight rising home prices and increasing density throughout the county. Our team began by analyzing U.S Census and American Community Survey (ACS) data made available on Social Explorer.

Population Density

Looking at density maps of Santa Clara County from the 2010 U.S. Census and from the 2011, 2012, and 2013 American Community Survey, our team observed a general increase in population density as the County's population rises. As population has increased, aggregate water use has stayed relatively constant. Indeed, as Figure 1 shows, water use in SCVWD has been relatively "steady" while population has continued to grow, showing that *per capita* water use declines as population grows. This may suggest that water conservation and efficiency efforts have been able to mitigate the rising population.

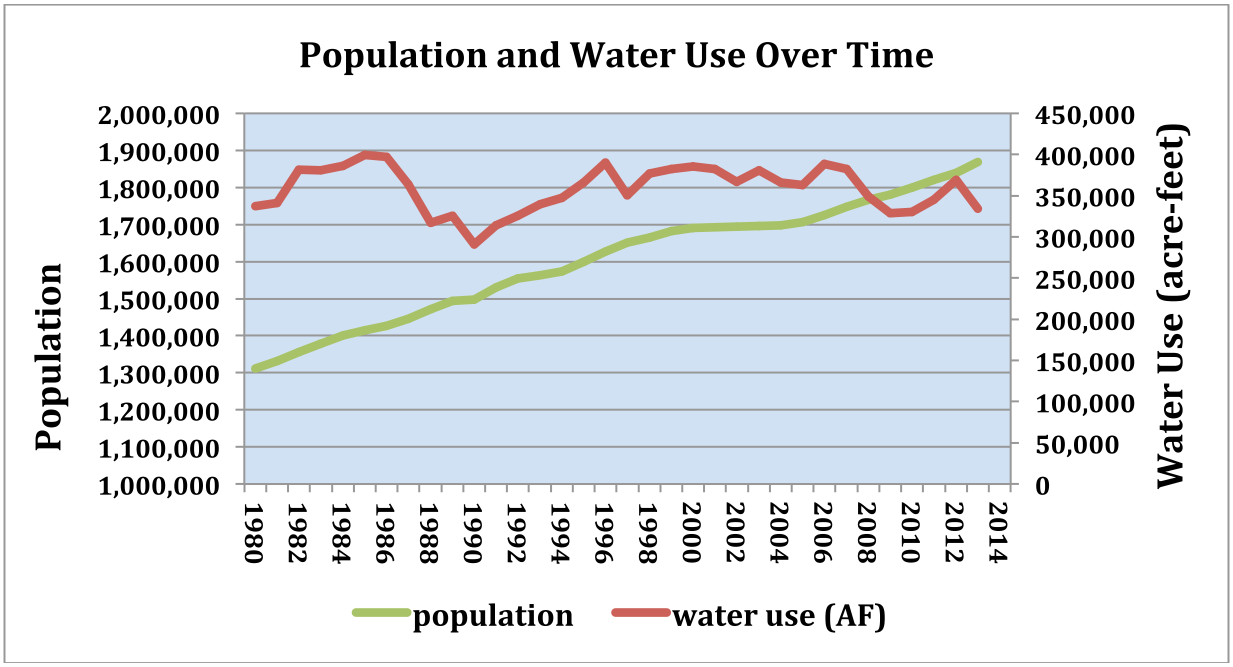


Figure 1: Population and Water Use Over Time in SCVWD
Source: SCVWD Annual Report.[9]

Developing technology may be a big contributing factor to this pattern. For example, several years ago, SCVWD distributed Pre-Rinse Spray Valves to restaurants and food stores that flowed at 1.6 gallons per minute. Today, sprayers that flow at 0.8 gallons per minute are being installed. With toilets, 1.6 gallons per flush was the standard, and now it is 1.28 gallons per flush. This is important to note for our data analysis on scalability because even though we can assume a sector is saturated with a certain device, we would have to account for technological improvements. Overall, water agencies should use the most efficient version of a particular device available, and SCVWD has been doing so as the historical trend shows.

The densest portions of the County lie in San Jose's city center with Palo Alto, Mountain View, and Santa Clara trail closely behind. On the contrary, parts of the East Bay (Milpitas) and the Southern areas of the county (Gilroy) are significantly less dense. Lastly, it is important to note that there is a good portion of the Eastern segment of Santa Clara County that is completely unmaintained by a water retailer. These residents live in *unincorporated* Santa Clara County and use well water or their own service provision.

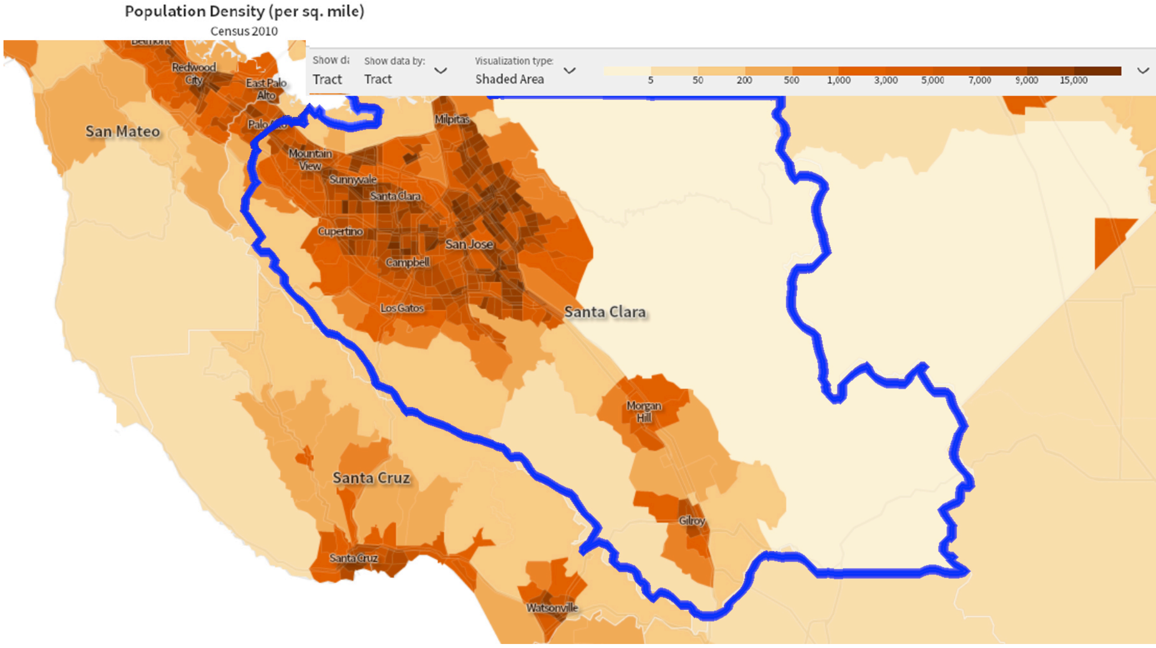


Figure 2: Population Density (per square mile).
Source: American Community Survey (ACS), 2013 Estimate

To put numbers on the longitudinal population density data we gathered from the ACS and the Census, we see that Santa Clara County is growing at almost double the rate California is growing at. This highlights the need for SCVWD to expand their water conservation and efficiency efforts to meet the demands of the growing population.

Table 1: Population in Santa Clara County and California

	Santa Clara County	**California**
2010 Census	**1,781,658**	**37,253,959**
2013 ACS	**1,862,041**	**38,332,521**
% Growth	**4.50%**	**2.90%**

Source: 2010 U.S. Census; American Community Survey (ACS), 2013 Estimate

Median Annual Income

Median household income varies greatly throughout Santa Clara County (SCC). The wide divergence means that different water retailers cater to different customer demographics. The San Jose Water Company caters to a very different population than the Palo Alto Water District; yet, both of these water retailers purchase water from SCVWD. Higher income customers might have the luxury to calculate the net-present value of water saving efforts as it relates to future payments. Conversely, lower income families might have limited options due to shorter time horizons in regards to finance as well as housing. However, low-income families might also be more motivated by economic incentives than wealthier families. San Jose's Great Oaks Water District, for example, serves a lower-income population yet our data shows high participation rates in many of the district's active rebate programs.

Population living in Group Quarters

Group quarters consist of multiple families living in one unit or building; an apartment or higher density living situation does not consist of a "group quarter" by the American Community Survey (ACS) definition.[10] Nearly all SCC residents live in single-family or multi-family homes. The rate of living in-group quarters is very low. Nonetheless, one might note that Stanford's census tract possesses very high rates of living in-group quarters. Portions of Santa Clara and urban San Jose do as well (these tracts are close to Santa Clara University and San Jose State University, respectively). Yet there are other group quarter spikes in the data, particularly in East San Jose.

Census tracts with a high percentage of residents living in-group quarters have disproportionality high levels of household water use. These group quarter numbers apply not just for college campuses, but also for any tract with a prison, mental facility, or hospital. The presence of high group quarters artificially increases per capita water use in these tracts (it also deflates income and alters most household indicators on the census).

Renter-Occupied Housing and Median Housing Value

As a general observation, the wealthier tracts of SCC have *fewer* renter-occupied units than the least well-off tracts of the County. Therefore, parts of Sunnyvale, San Jose, and Santa Clara have higher proportions of renters as opposed to owners of homes. The tracts in Palo Alto, Western Mountain View, and Cupertino are almost exclusively owned. Owning one's home creates direct and symmetric incentives for water conservation. On the other hand, renters are in no way incentivized to participate in programs like the Active Water-Wise House Call (WWHC). Moreover, renters rarely pay the water bill so they lack knowledge or incentives to use water economically. Water conservation and efficiency are in the best interests of landlords, but they may struggle between performing water audits and inconveniencing renters. Therefore, we might expect to see retailers with larger rental units struggle to have the same participation rates as their owner-occupied tract counterparts.

Poverty Level and Hispanic / Latino Residents

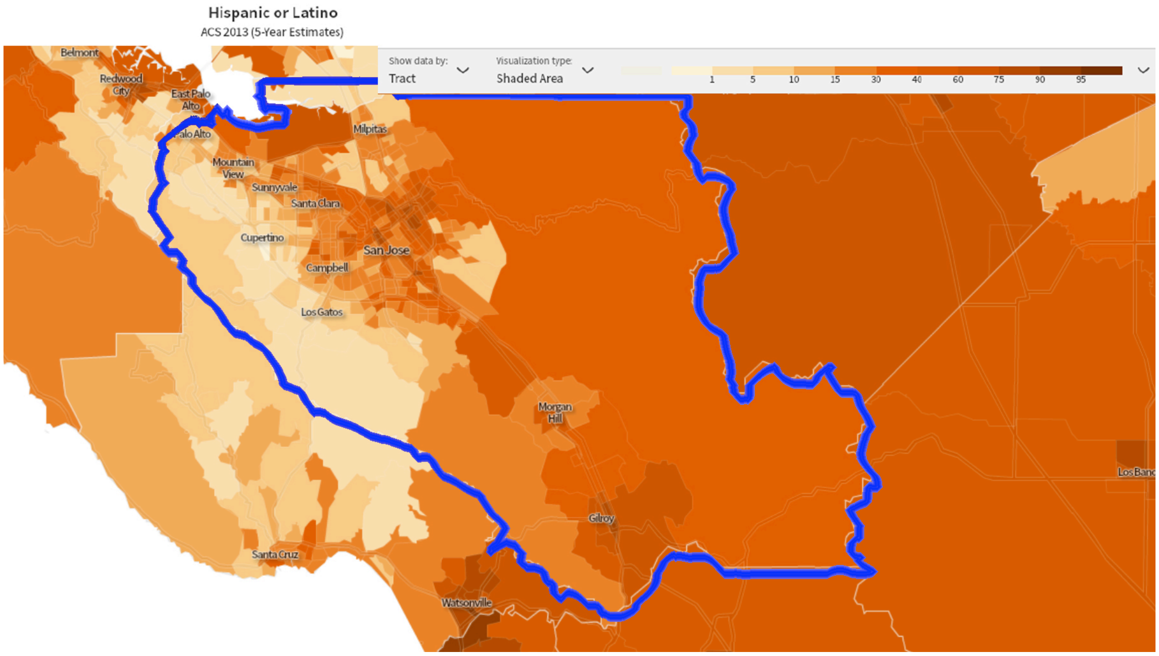


Figure 3: Estimated percentage of the population living in poverty
Source: American Community Survey (ACS), 2013 Estimate
Note: A darker color connotes a higher percentage of the population living below the 2013 poverty level, in "Natural Breaks" from 0 to 75%.

Our final census image shows the percentage of Santa Clara County living below the poverty level. This indicator is highly correlated with the County's Hispanic / Latino population. There is a much larger Hispanic population in the County than there are families living below the poverty line, but the geographic area of concentrated poverty is highly Latino.

Families living below the poverty line might struggle to devote the necessary time and resources to initiate an active rebate program or even participate in a Water Wise House Call. Moreover, since many of these families are Hispanic, household members may not be proficient in English. Many water retailers carry out water audits, in which trained surveyors visit households to measure their water use, in both English and Spanish. In particular, Great Oaks Water District conducts all services in both languages, since their district caters to a largely Hispanic population.

3. CONSERVATION AND EFFICIENCY PROGRAMS

Water use per capita can be reduced and productivity of water can be increased through conservation and efficiency programs. Conservation efforts focus on behavioral change to save physical volumes of water, while efficiency programs enhance the productivity of water to by providing equal or better outcomes with less water. Conservation and efficiency programs can be implemented as:

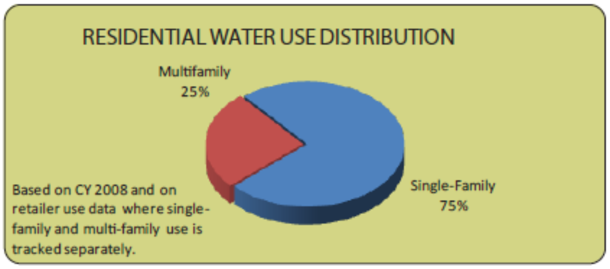
- *Passive Programs* – A systematic approach to reducing water use and increasing efficiency that does not engage with the end users. Passive conservation, in other words, refers to water savings resulting from customer actions and activities, which do not involve, or depend on, direct assistance from supplier-assisted conservation programs.[11] Federal and state plumbing codes and ordinances that regulate water use serves as a great example.

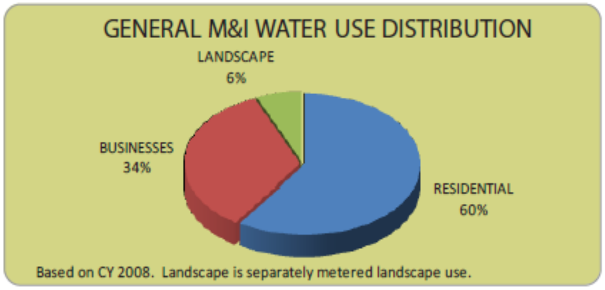
- *Active Programs* - Public programs circulated in the community that attempt to decrease water use and increase efficiency by engaging end users in water efficiency and conservation efforts. Active conservation thus refers to incremental savings resulting from supplier-assisted conservation programs. Rebates and public outreach are some examples of active programs. After specific number of years *Active Programs* will move to passive category.

Our team performed our analysis on ten residential, commercial, and irrigation programs based on our given data and which programs we inferred to have the greatest impact:

1. Residential High Efficiency Toilet
2. Residential Clothes Washer
3. Residential Survey/Water Wise House Calls
4. Residential Showerhead
5. Residential Aerator
6. Residential Turf Removal
7. Commercial Clothes Washer
8. Commercial Pre-Rinse Sprayer
9. Commercial HE Toilet
10. Irrigation Technical Assistance Program (ITAP)

For a sample of other programs carried out by SCVWD, please see Table 2 below. Our team gathered information (costs, start date, effectiveness, and ease of use) on some of the passive and active programs listed below by sorting through data provided by SCVWD. Based on the 2010 Urban Water Management Plan, 34% of the District's water use is business, 6% landscape, and 60% residential.[12] Of the residential water use, 25% is multifamily and 75% single-family.





Figures 4 and 5: District Residential Water Use Distribution, and General Municipal and Industrial (M&I) Water Use Distribution, both by zoning category.
Source: Santa Clara Valley Water District.[13] *Based on Calendar-Year 2008 data.*

Table 2: Examples of Santa Clara Valley Water District Savings: Passive and Active

Passive	Active
CII Toilets CII Urinal SF Toilets (ULFT/HET) MF Toilets (ULFT/HET) SF Showerheads MF Showerhead SF Aerators MF Aerators SF Clothes Washers MF Clothes Washers SF Dishwasher MF Dishwasher	Residential Surveys, SF Residential Surveys, MF Residential ULF Toilets, SF Residential ULF Toilets, MF Residential HE Toilets, SF Residential HE Toilets, MF Residential LF Showerhead, SF Residential LF Showerhead, MF Residential HE Washer, SF Residential HE Washer, MF Residential Irrigation Controller, SF Residential Turf Replacement CII 1/2 Gallon Urinal CII ULF Toilet CII HE Toilet CII Laundromat CII Spray Rinse Valve

Source: Santa Clara Valley Water District Urban Water Management Plan and Subcommittee Reports

While both business and residential customers participate in SCVWD programs that aim to lower water use, much of the potential for water conservation lies in single-family residences.

In addition to the active programs SCVWD carries out, the district also employs other outreach techniques that have the aim of reducing water use and increasing water efficiency. SCVWD's award-winning school program has reached thousands of students from Kindergarten all the way to College. The instructors are able to cover every water topic imaginable and tailor their courses to the students. It is SCVWD's hope that the students internalize the lessons and practice water conservation tactics in their lives as well as teach their family at home. SCVWD also participates in community outreach events by tabling at public fairs, going to expos, and creating easily understood flyers and infographics in various languages.

4. METHODOLOGY

The goal of our project was to identify which of SCVWD's conservation and efficiency programs have most effectively decreased water use in the past twenty years. Our research focused primarily on active programs because passive programs are not tracked as fully and financially covered entirely by SCVWD. Passive programs for instance have lifetimes that span different lengths, making it hard to parse out specific water savings from these programs. Additionally, other parties such as local jurisdictions pay part of the costs of infrastructural improvements and zoning regulations, making it difficult to accurately determine the cost-efficiency of passive programs.

As a result, we narrowed down our evaluation to ten of SCVWD's active programs. We analyzed residential, commercial, and irrigation programs and created a ranking system based on what our team found to be the most desirable metrics for measuring what a "successful" program entails: **cost-effectiveness, impact, and scale**. We believe that a successful water conservation program that is cost-effective and understandable by the general public, will have a positive impact when it comes to reducing per capita and aggregate water usage. A successful program must also be scalable in so much as it can apply to large portions of the SVWD customer base. We justify *why* each criteria is important below:

Cost-effectiveness

Cost-effectiveness measures cost as it relates to impact of the dependent variable: water conserved. Here, cost-effectiveness compared the cost of SCVWD conserving a drop of water to the cost of providing a drop of water. Such cost effectiveness is marginal in nature. If the marginal return on a conservation program equals or exceeds the marginal cost, then such a program is considered "cost-effective." As an equation, we can represent cost effectiveness as follows:

$$\mathrm{MIN}_{x,y}\{A\bullet(1-P(x,y)) - (w_x x + w_y y)\}$$

A = cost of conserving additional water

x = (benefit of saving water)

y = (social benefit of saving water)

P = Probability of program being used to its full potential

Solution:

$W_x = A\bullet(\partial P/\partial x)$

$W_y = A\bullet(\partial P/\partial y)$

A note on our cost-effectiveness supply-side formula: We based our formula loosely off of Brown's Rule for dictating marginal economic utility. Our team understands that conserving water has a cost (A), which must be borne by SCVWD. Our team begins by assuming that there is a *full* participation rate, which will never occur. Instead, only a *subset* of the population will use such programs, which is delineated by P and (1-P). There is also a benefit to water programs, both for the SCVWD's bottom line (x) and for society (y). X will likely feature more prominently into SCVWD's decision than will y, although policymakers might be curious about the societal implication of each drop of water conserved. One must then consider this equation on the margin by taking the partial derivatives for x and y. We want to *minimize* the cost of a conservation program (we want to minimize cost minus benefit) but an alternative equation might seek to *maximize* benefit minus cost. Should the outcome (0,0) arise as the most efficient minimum point, then the program is unfortunately not cost-effective.

  - For consumer demand, *rebates* and participation must also be cost-effective. Due to the longitudinal nature of water rebate benefits, consumers investing in large upfront costs of water infrastructure upgrades may not see benefits in the short-term. However, equations can help illustrate whether a program is cost-effective for consumers over time. Our team has developed a Net Present Value (NPV) model to consider the effectiveness of water conservation for customer rebate programs:

$$NPV = \frac{B_0 - C_0}{(1+i)^0} + \frac{B_1 - C_1}{(1+i)^1} + \ldots + \frac{B_T - C_T}{(1+i)^T}$$

NPV = Net Present Value
t = year
B = benefits
C = cost
i=discount rate

A note on our cost-effectiveness demand-side formula: We based our formula loosely off of Net Present Value calculations for any long-term investment, since water rebates mirror this financial structure. In essence, we expect a *large* upfront consumer cost (C_0) and then small but continuous benefits (B_1, B_2, etc.). At what point do benefits equal costs? Such calculus will help consumers determine whether rebate programs are worthwhile. Our team expects that demand-side NPV analysis is not fully relevant to every SCVWD consumer. Budget-maximizing consumers might avoid costly water conservation programs, but socially conscious customers might find *added value or utility* by decreasing their environmental footprint. Therefore, the social benefits to water conservation and efficiency ought to be calculated in the equation's "benefits" section.

Given the realities of SCVWD's budget and of cost-conscious consumers, any solution we propose and implement must be cost-effective. Rebates on items that would help conserve water, such as high-efficiency toilets (HETs), might be more effective should they be larger. Yet at some point full rebates are simply not economically feasible and might not even raise awareness or increase impact more than generous partial rebates. Our team examined the costs, benefits, and potential drawbacks of the status quo and potential solutions through the lens of cost-effectiveness.

Cost - Efficiency = Output/Input = Total Savings/Total Costs (in AF/$)
Where, Total Costs = Participation * Per Unit Utility Cost.

Constraints on measuring cost-effectiveness: The use of both Brown's rule for supply-side marginal water use and the net-present value for consumer savings are aspirational metrics. Our team received cost data in the form of the Water Savings Annual Activities report from the Santa Clara Valley Water District. Please see **Appendix Three** for a list of water savings, both longitudinally and by programs. Our team was able to consider these costs, as the Brown rule would indicate, by looking at the *marginal utilities*; we examined costs on a per unit basis. Additionally, the savings sheet's longitudinal nature would allow for a Net-present value discounting to occur over time for the consumer. For the purposes of this report, our team considered the *supply-side* component of cost-effectiveness only, as it determines which programs are most cost-effective.

Impact

We considered any proposed conservation plan's impact, at the aggregate level, as it relates to both total savings and participation rates. A program that is cost-effective but does not affect a large number of households in the district is not a program with high impact. A passive program, one that might not change behavior but nonetheless reduces a great deal of district household water use through efficiency, also has a high positive impact. To find impact mathematically, we used the following mathematical justification:
To find our impact measure, our team integrated the total savings equation with respect to *participation*. In effect, this gave us the area under the curve of a graph with "total savings" on the y-axis and "participation" on the x-axis. Finding this integral gave us the *aggregate* impact as it relates to participation rates.

Impact = [∫(Total Savings = ∑(Savings per year)*participation] / (# of yrs operated)
Impact = (Total Savings)*(Participation rate) / # of yrs operated

Impact = (Acre Feet [1]/ Person)*(Numer of People) / Year
Impact = Acre Feet / Year

** Impact units are in Acre Feet*

Constraints on measuring impact: The SCVWD data on "participation rates" is meant to reflect the number of district households participating in a given program. Yet such data might be limited in accuracy given the variance on the number of people (ranging from 1 to many) living in a district household. At the aggregate SCVWD level, these numbers even out to arrive closely at the 2.2 people per household average. But at the individual retailer level, these numbers might vary more widely. As our census data show, some retailer areas have high percentages of people living in-group quarters, or just have larger families, than others. This might depress the per program impact in low-density areas (Palo Alto, Mountain View) and increase the true impact in higher density retailer areas like San Jose.

In addition, impact's "participation" rate cannot be measured at the aggregate level, but only yearly. Each of the programs we studied have operated for a different number of years; for example the Residential Washer program has operated for 18 years but the Residential Turf program has only been in operation for 8 years. Therefore, we divide the total impact by the number of years the program has been in operation to get an average yearly impact, in Acre-Feet per year.

Scale

Our team considered scale, how large of an effect a program can have, in terms of number of people, amount of water saved, and longitudinal impact, as our final evaluative criterion. Some programs (like hyper-local advertising or a critical passive water upgrade) might be very cost-effective and might also have a tremendous impact on per capita water conservation, but may only produce a localized impact. Our team understands that water conservation comes from changing individual norms and behaviors, but with hundreds of thousands of customers, SCVWD must think in terms of "economies of scale" to successfully reduce overall water.

To find *scale*, our team took the total *participation* rate for a specific program divided by the number of households in the Santa Clara Valley Water District.

Scale: (Total participation rate, in Units) / (# of Households in SCVWD)
Scale: (Total participation rate) / (589,172 households)

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[1] *Acre-Feet (AF)* – An acre-foot is the standard measurement for large quantities of water. One acre-foot equals 326,700 gallons of water. To envision what an acre-foot looks like, one can picture a football field (approximately one acre) covered one-foot-deep in water.

** Scale units are "# of households/showerheads/calls per household"*

Constraints on measuring scale: The number of households is lower than the true census figure because our team is missing (1) California water retailer households and (2) households in unincorporated Santa Clara County. These household amount to a small portion of the district's 1.8 million population. While this could make our scale estimates artificially high, it is also worth mentioning that the "total participation numbers" from SCVWD does not include neither the households in the California Water Service Company nor in unincorporated parts of Santa Clara County. Additionally, our team recorded "scale" measurements in all programs for which we have yearly data; this may deflate our numerator and make our estimates smaller, depending on the number of program years for which we do not have data. Lastly, our data for "Water Wise House Calls" are slightly low because the City of San Jose runs a parallel program, called Water Watcher Audits, which also save water but are not measured by SCVWD as an independent contractor runs them. These conservation efforts and other efforts outside of the official SCVWD activities are not a part of our formal participation rate.

Our scale measurements are only as effective as our "total participation rate" figures given from SCVWD. We assume that these participation rates include all people participating in a given program, throughout the district. This assumes that our team has data for each year the programs have operated. Lastly, our scale measurement alone does not account for the *savings* of water. Scale is concerned with the number of people who use a program as it relates to the program's potential; we wish to consider *how each program might be able to grow and scale to affect all SCC residents*. Yet scale does neither consider the per-person water saved nor the cost of running or operating the program. In isolation, our cost-effectiveness, impact, and scale measures do not present the full picture of our programmatic analysis. Yet when synthesized, they offer a robust and comprehensive look at the SCVWD's top programs.

5. DISCUSSION AND RESULTS: WHAT WORKS IN SANTA CLARA VALLEY AND WHAT CAN BE IMPROVED

In order to better gauge the success of each individual program in a comparable nature, we decided to divide the water retailers into three categories based on the number of households served. Table 3 presents number of household in each retailer.[14] Large Metro Area Retailers include distributers who serve over 40,000 homes, Medium Metro Area Retailers serve 14,000-40,000 households, and Small Metro Area Retailers serve less than 14,000 households. With this apportionment, we were able to see some interesting results amongst retailers of comparable size.

Table 3: Retailers and respective households served in SCVWD.

Retailers	**Households Served**
Large Metro Area	
San Jose Water Company	318,543
City of Sunnyvale Public Works Department	63,580
City of Santa Clara Water Department	48,933
San Jose Municipal Water System	43,955
Medium Metro Area	
City of Mountain View Public Works	30,617
City of Palo Alto Utilities Department	28,921
City of Milpitas Community Services	19,663
Gilroy Community Services Department	14,534
Small Metro Area	
City of Morgan Hill	10,020
Great Oaks Water Company	7,120
Purissima Hills Water District	2,302
Stanford University, Utilities Division	984

Source: Data provided by Santa Clara Valley Water District.[15]

We used household numbers as a proxy to find the participation rate of active programs. To best discover the magnitude of participation between the retailers and across the population spread, we divided participation numbers given by SCVWD by the number of households served by that retailer. This gave us the participation rate for each active program in each retailer division.

Within our data, we had to make a number of assumptions. First, for many of the programs that have been around for a while, we did not have data for years prior to 2003. For some retailers, this discounted any efforts made before 2003 in these select programs. Therefore, their cumulative numbers are not reflective of the total number of people participating in these programs. Also, some retailers have utilized their own programs that are comparable to the programs run by SCVWD. For example, San Jose Water retailer runs a household survey program that is very similar to the WaterWise house call program. Since we did not have the numbers for these individual retailer programs, some of the retailers water conservation efforts may be understated.

Unfortunately, we were not able to conduct a participation rate analysis for all retailers and all programs. We could not include California Water Service Company data because the retailer was unable provide us with an estimate of the number of households they service. In cases where we were unable to obtain direct household data for a retailer, we used the most up to date population count (from either a city-reported number or the 2010 census) and divided that by the reported average number of people per household.

In addition, we could not analyze commercial or industrial program participation rates because we were unable to estimate the number of total possible participants by retailer. For example, the number of clothes washer businesses in each retailer's jurisdiction was unattainable. Below we analyze the five residential programs with the most data available.

High Efficiency Toilet

When analyzing High Efficiency Toilet Rate trends between retailers in each block, we see in Figure 8 that Small Metro Area retailers have outperformed the other retailers in Figure 6 and Figure 7. As it appears, our numbers show that the Large Metro Area Retailers generally have not garnered a larger proportion of their population under this HET rebate as compared to the other retailers. All three metro areas seem to have an upward trend, which suggests that they have not yet reached their saturation ceiling.

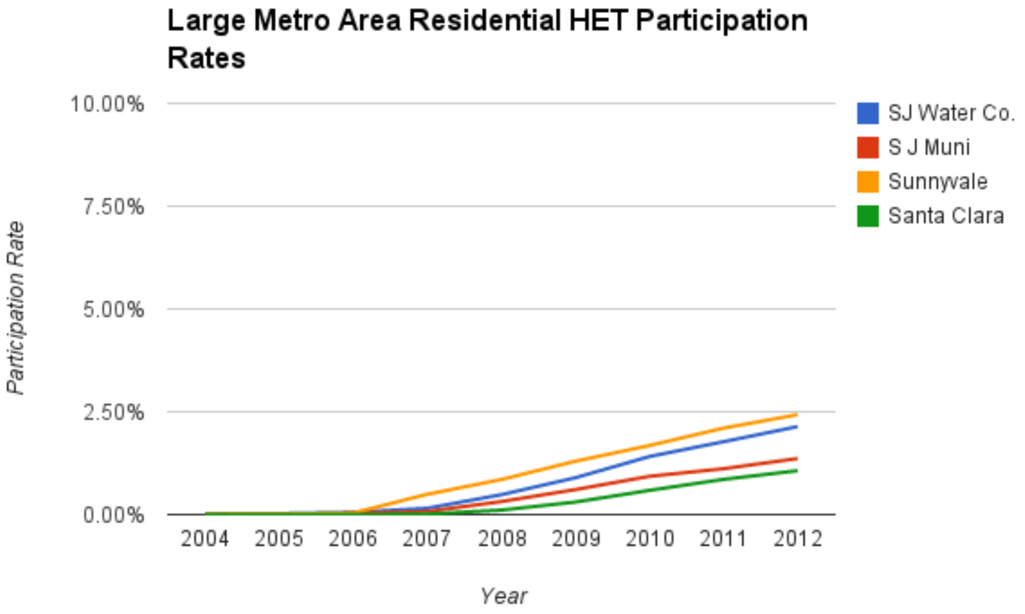


Figure 6: High Efficiency Toilet (HET) program for Large metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

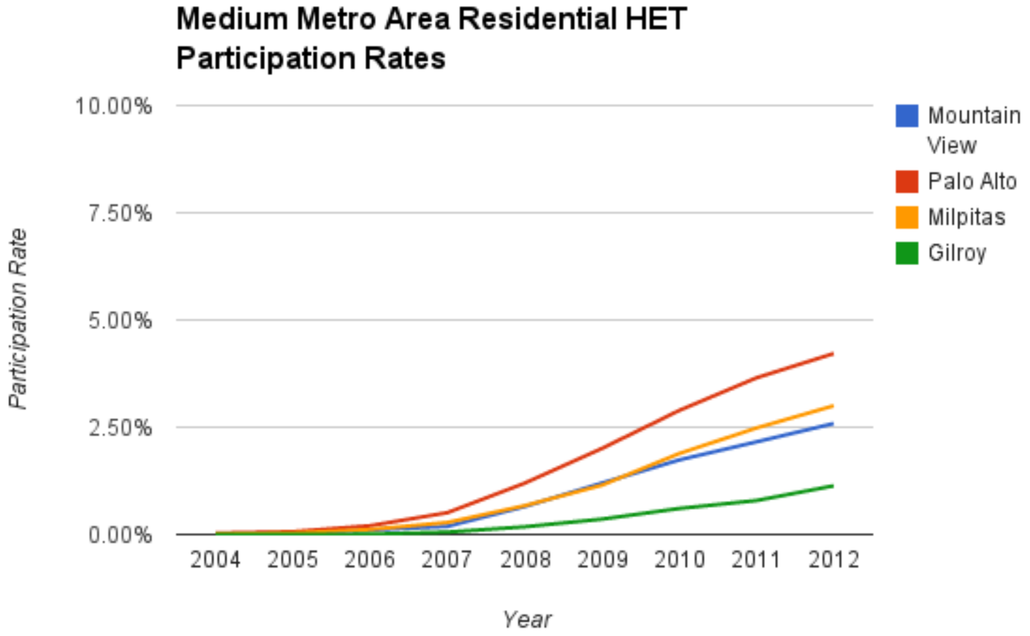


Figure 7: High Efficiency Toilet (HET) program for Medium metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

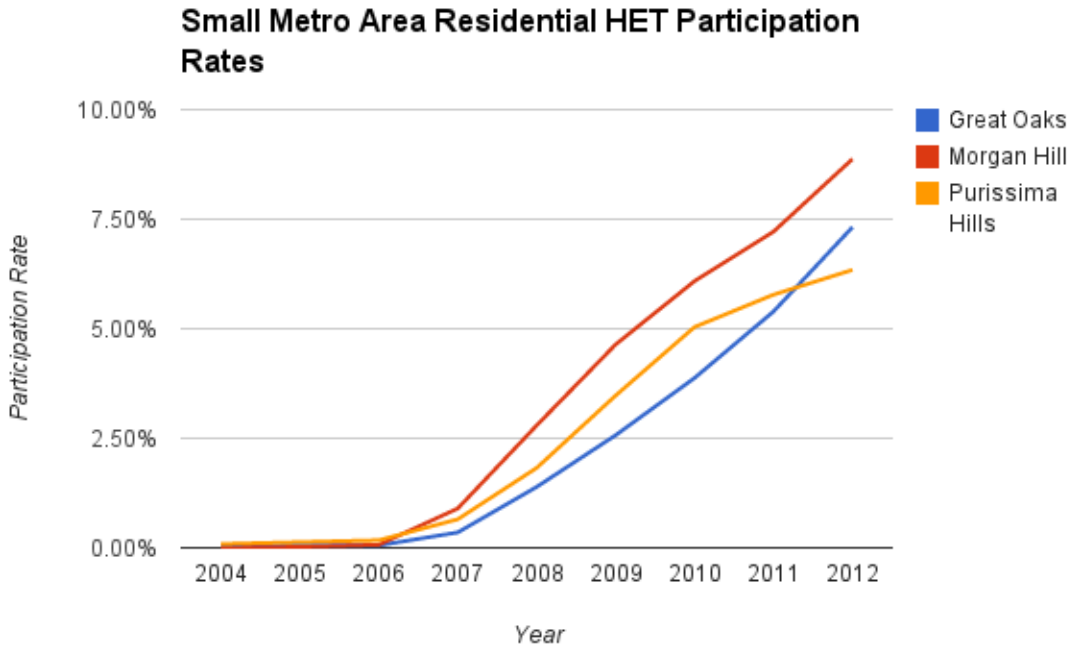


Figure 8: High Efficiency Toilet (HET) program for Small metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

Residential Clothes Washers

In the Residential Clothes Washer Program, Great Oaks is a clear outlier compared to the other retailers. According to our data, almost 94 percent of the households in Great Oaks received a Washer rebate from SCVWD. For the rest of the retailers, most of them do not reach the 25 percent participation rate. Further investigation into how Great Oaks found success may allow replicating these results for other water retailers. Again, as all retailers continue to have a positive trend, they probably have not yet reached their saturation ceiling.

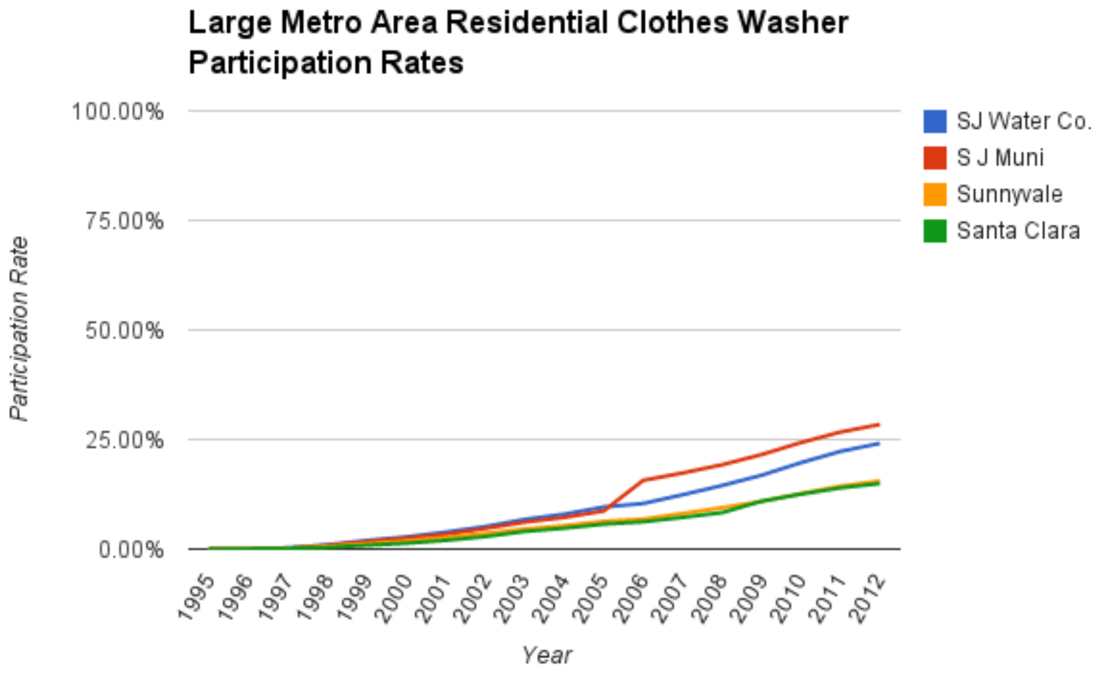


Figure 9: Residential Clothes Washer program for Large metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

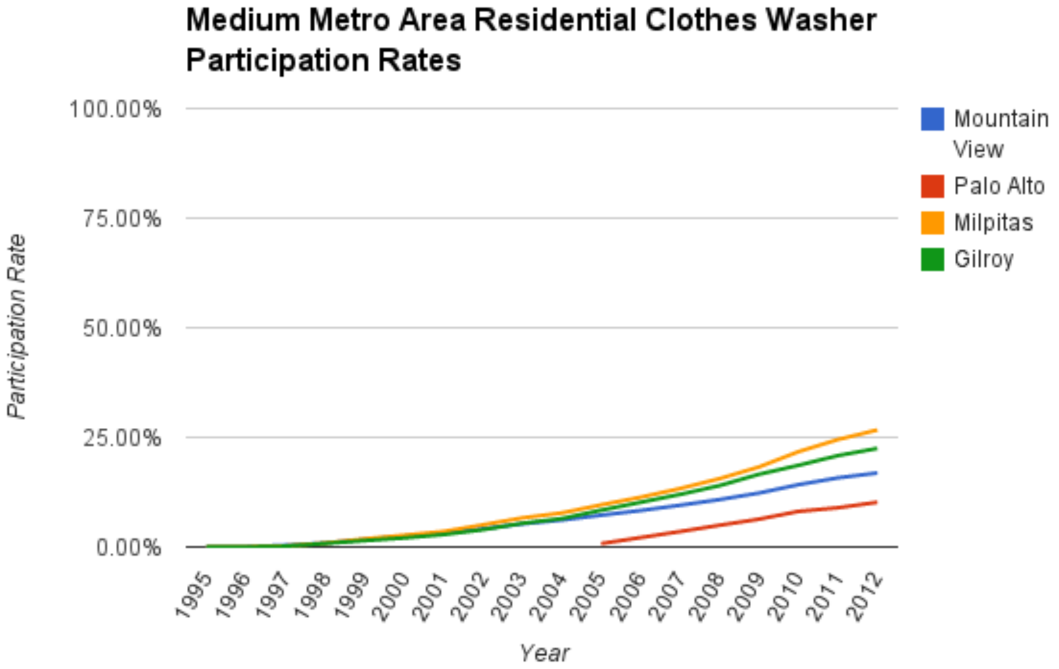


Figure 10: Residential Clothes Washer program for Medium metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

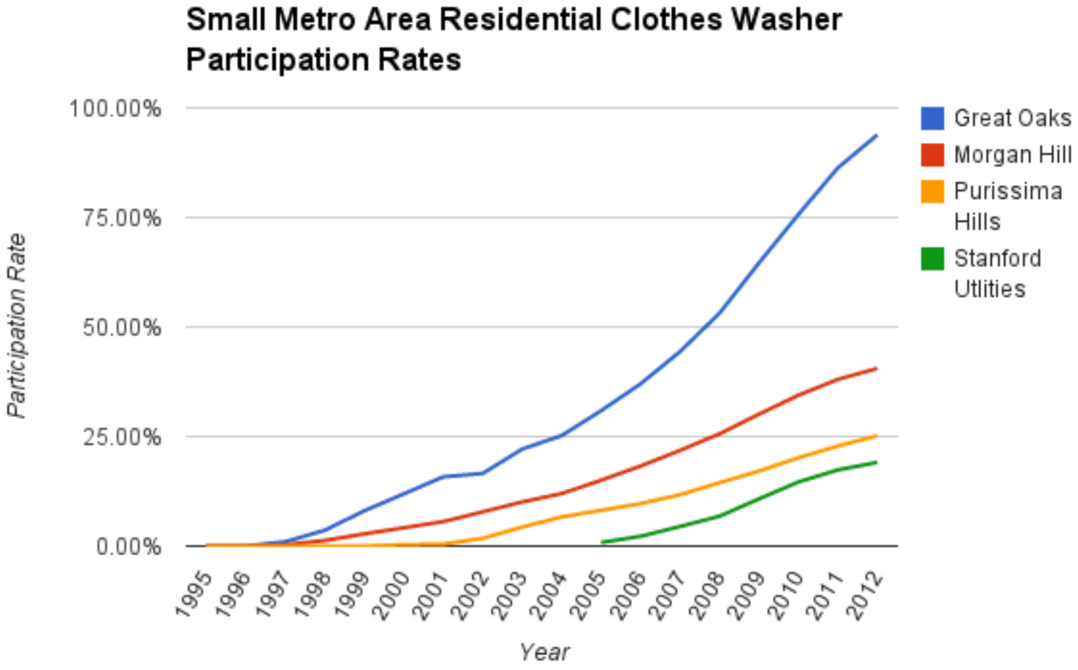


Figure 11: Residential Clothes Washer program for Small metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

Water Wise House Calls

In regard to the Water Wise House Call Program, according to our data, the Large Metro Area Retailers in Figure 12 generally have the lowest participation rates. While San Jose Water Co. appears particularly flat, their numbers are grossly understated because they perform their own Water Audits via an independent contractor. Since SCVWD does not administer their audits, the data does not appear here. The large metro area retailers seem to be reaching their saturation ceilings as their trends seem to be flattening in most recent years.

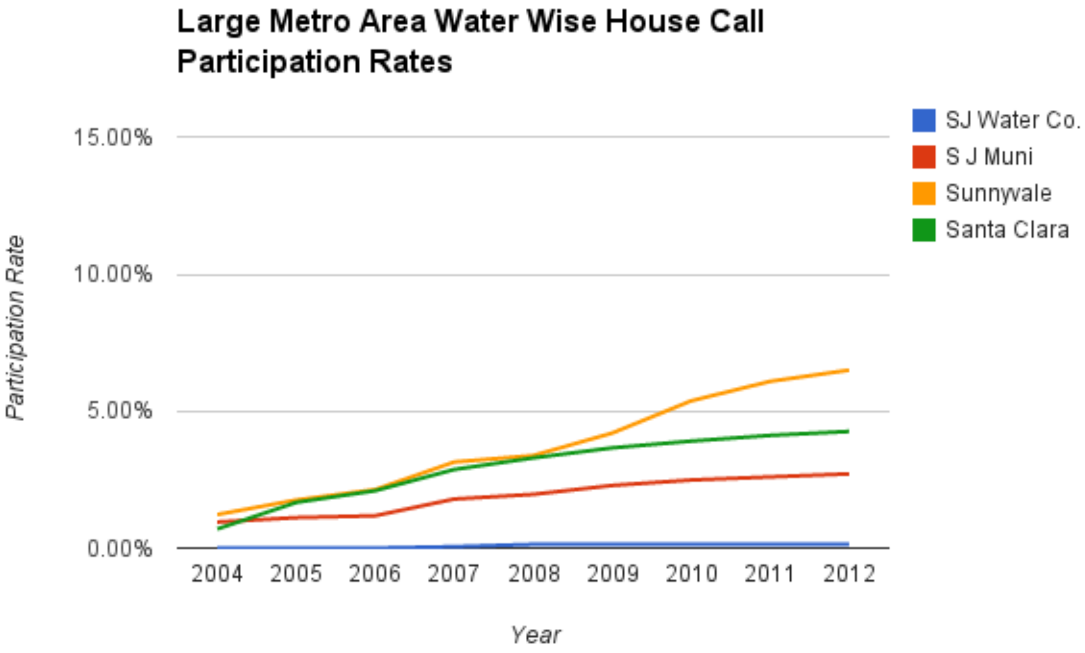


Figure 12: Water Wise House Calls (WWHCs) for Large metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

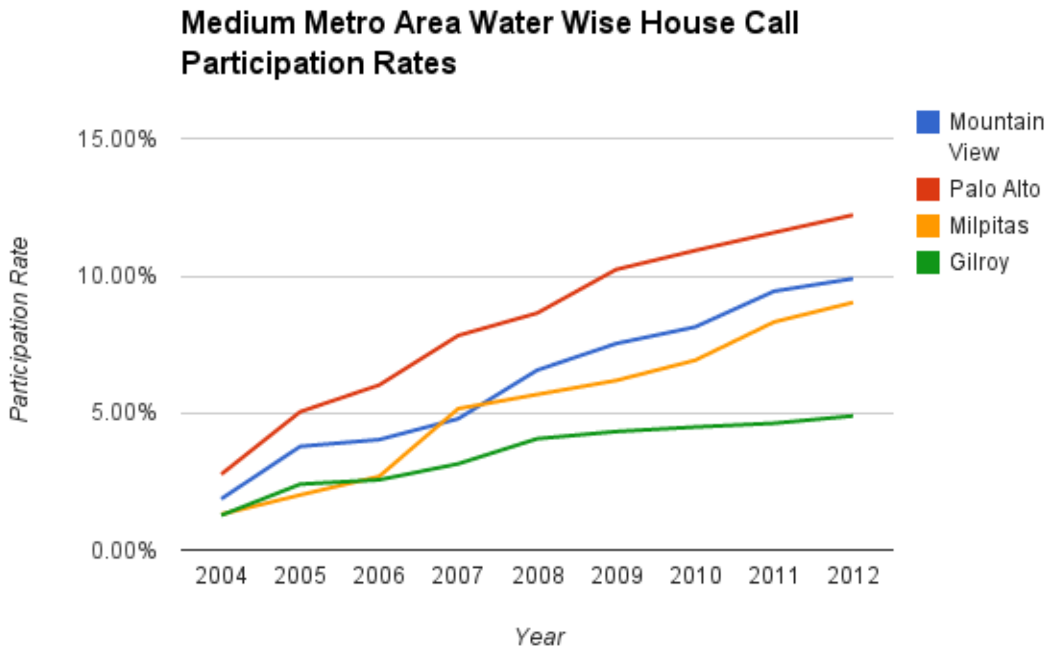


Figure 13: Water Wise House Calls (WWHCs) for Medium metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

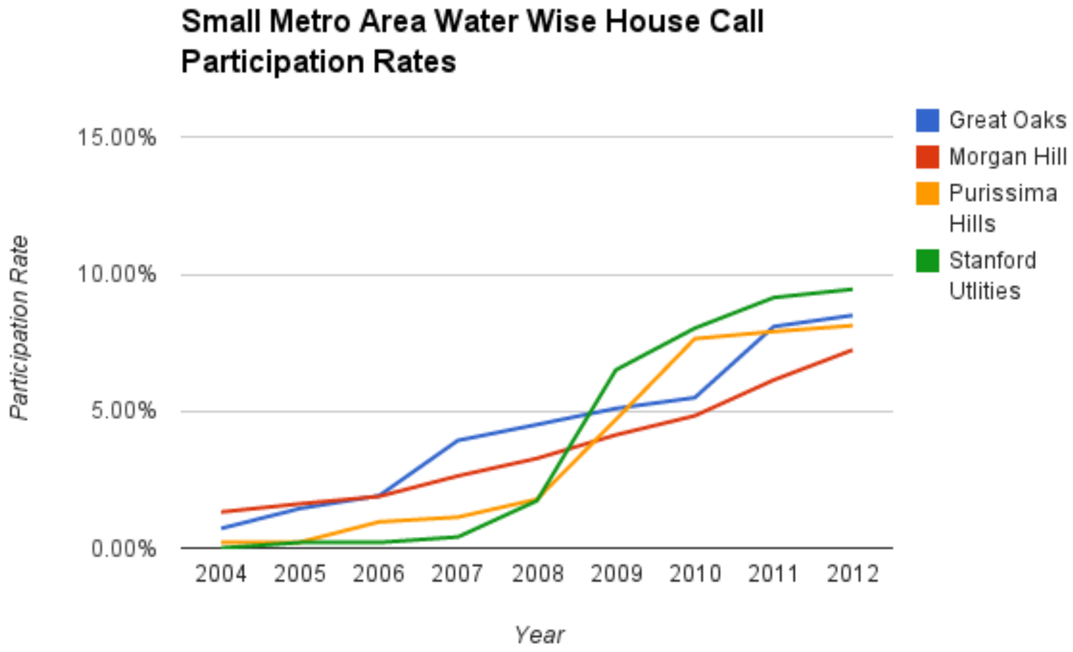


Figure 14: Water Wise House Calls (WWHCs) for Small metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

Showerhead Retrofit

For the Showerhead Retrofit Program, the Small Metro Areas in Figure 17 once again outperformed the other water retailers. With the exception of Great Oaks, the Small Metro Areas are the only retailers with participation rates above nine percent. Further investigation into why Great Oaks only has 12 total showerhead participants through 2012 would be beneficial. With the exception of Purissima Hills, all the retailers seem to have reached their saturation ceilings because their trends have been relatively flat for several years, but as mentioned before, our assumption would need to take into account recent improvements in technology.

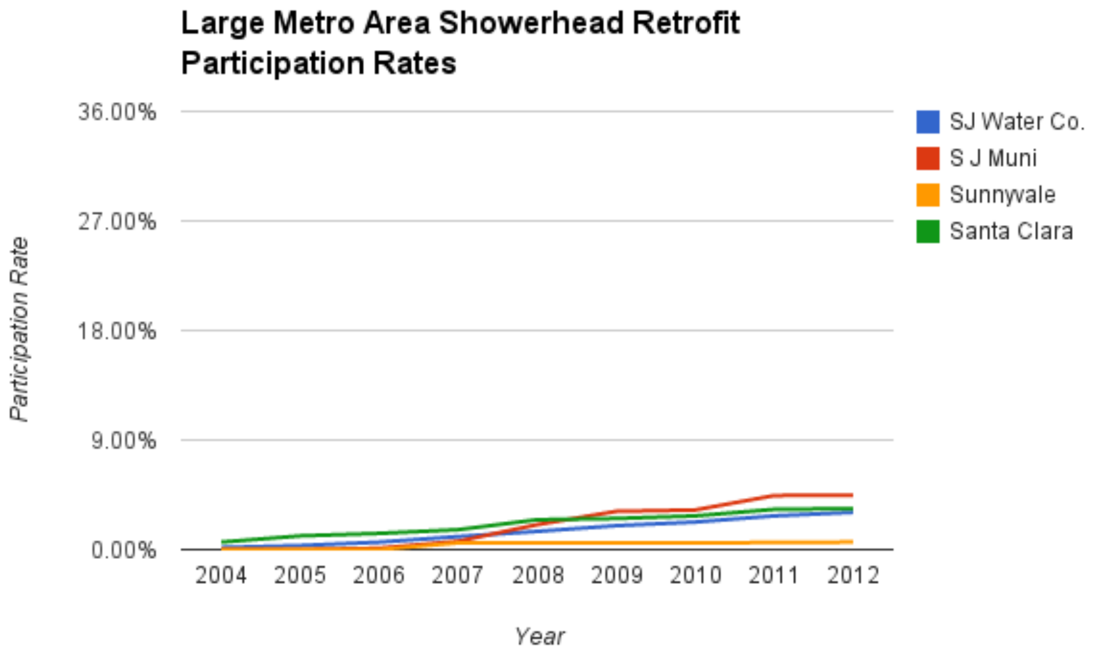


Figure 15: Showerhead Retrofit Program for Large metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

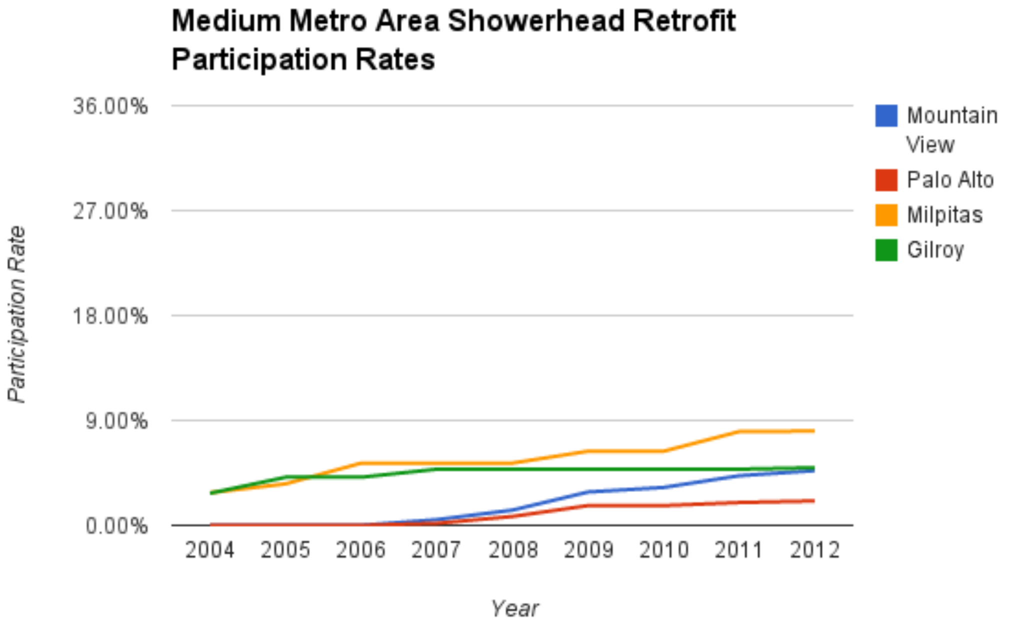


Figure 16: Showerhead Retrofit Program for Medium metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

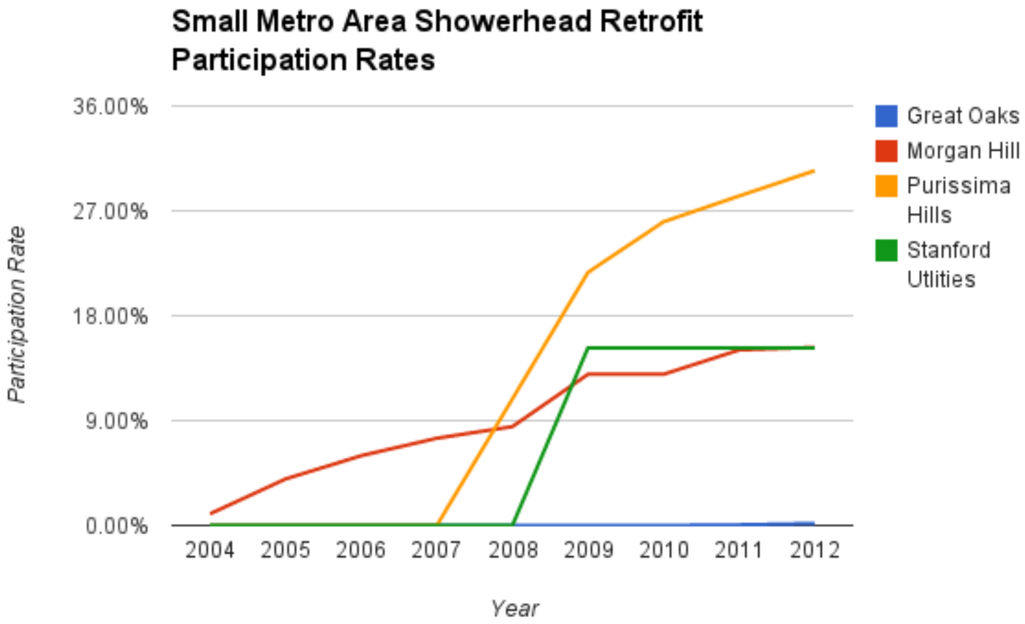


Figure 17: Showerhead Retrofit Program for Small metropolitan retailers
Source: Data provided by Santa Clara Valley Water District

Aerator Retrofit

For the Aerator Retrofit Program, many of the retailers also have relatively flat participation rates. Again, this may indicate that the program has reached its saturation ceiling. The Small Metro Areas in Figure 20 may have some bad assumptions about the number of aerators per households because Purissima Hills and Stanford Utilities both have participation rates over 100 percent. This suggests, nonetheless, that these retailers have high participation rates compared to other retailers. With the exception of Great Oaks, who has a participation rate near zero, Small Metro Areas once again outperform the other retailers.

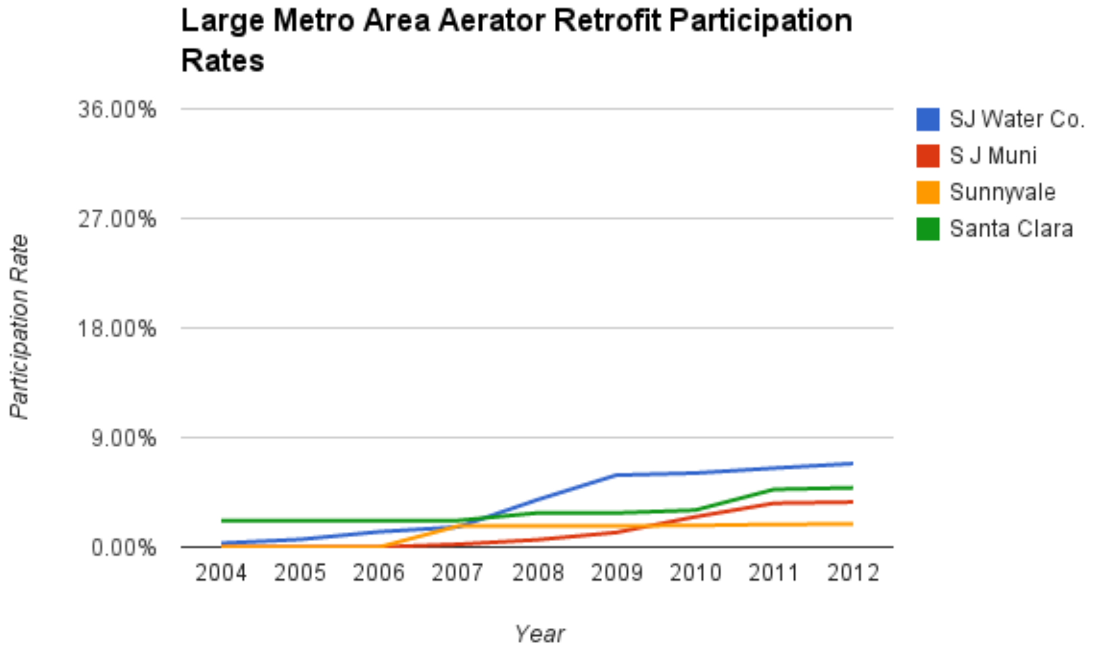


Figure 18: Aerator Retrofit Program for Large retailers
Source: Data provided by Santa Clara Valley Water District

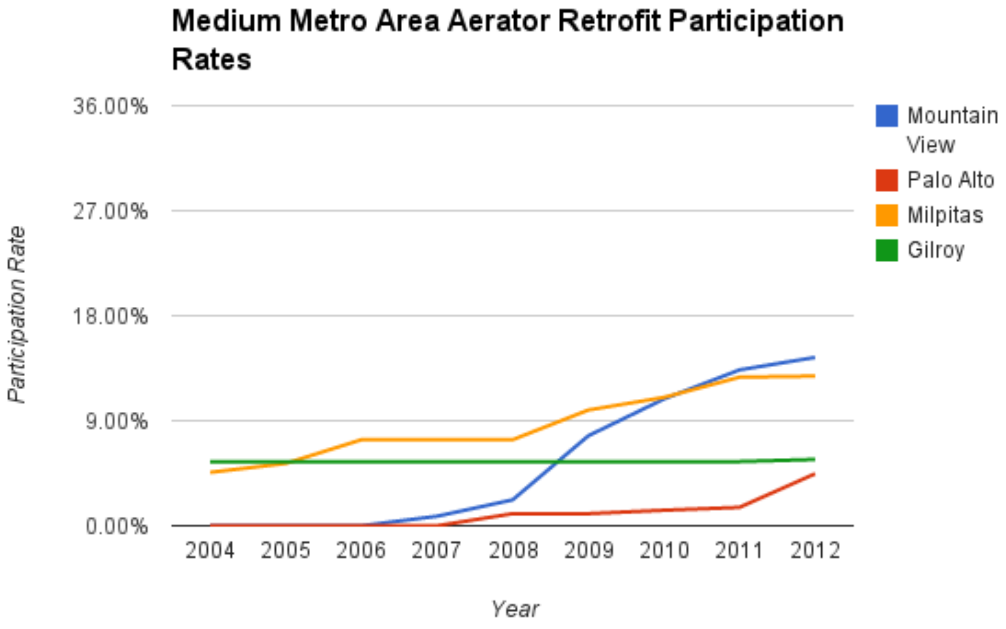


Figure 19: Aerator Retrofit Program for Medium retailers
Source: Data provided by Santa Clara Valley Water District

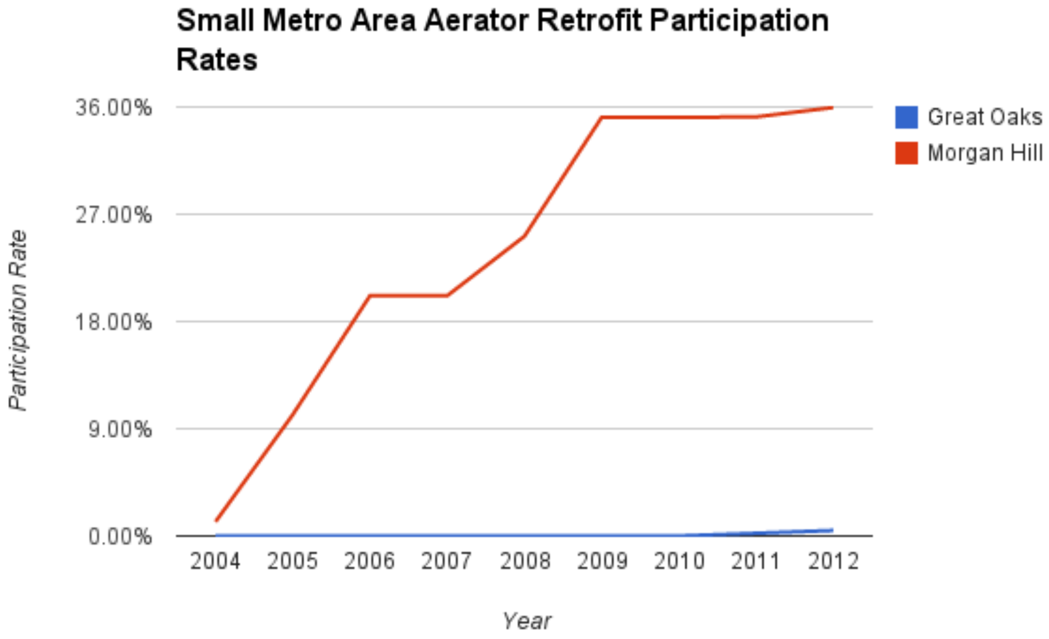


Figure 20: Aerator Retrofit Program for Small retailers
Source: Data provided by Santa Clara Valley Water District

Initial Findings

Our team finds that across programs, Small Metro Area retailers generally engage larger portions of their populations than do the larger retailers and retailer participation rate rankings vary by programs. In regards to saturation ceilings, most programs have not yet reached their full potential. Programs that near their ceiling may reduce their scale rankings, however, further investigation into those programs could lead to more accurate results. Perhaps most interestingly, Great Oaks has a tremendous degree of success with Clothes Washer Rebates with nearly all residents participating, but has effectively no participation in the showerhead and aerator programs. While deeper investigation into these trends may explain some of the discrepancies, our retailer analysis helps us (1) frame the programs our team ought to consider analytically for cost-effectiveness, impact, and scale, and (2) consider water conservation and efficiency as they relate to the demographic realities of Santa Clara County.

Program Evaluation Scorecard

Given our three criteria of cost effectiveness, impact, and scale, our team considered an evaluation of all Santa Clara Valley Water District programs. We examined both the status quo and proposed alternatives (expanded programs, new incentives, smaller tweaks, larger changes) through evaluation chart 5.2-1. Each section of the chart includes our own analysis on various elements of a program or policy's effectiveness:

Table 4: Analytical framework for cost-effectiveness, impact, and scale

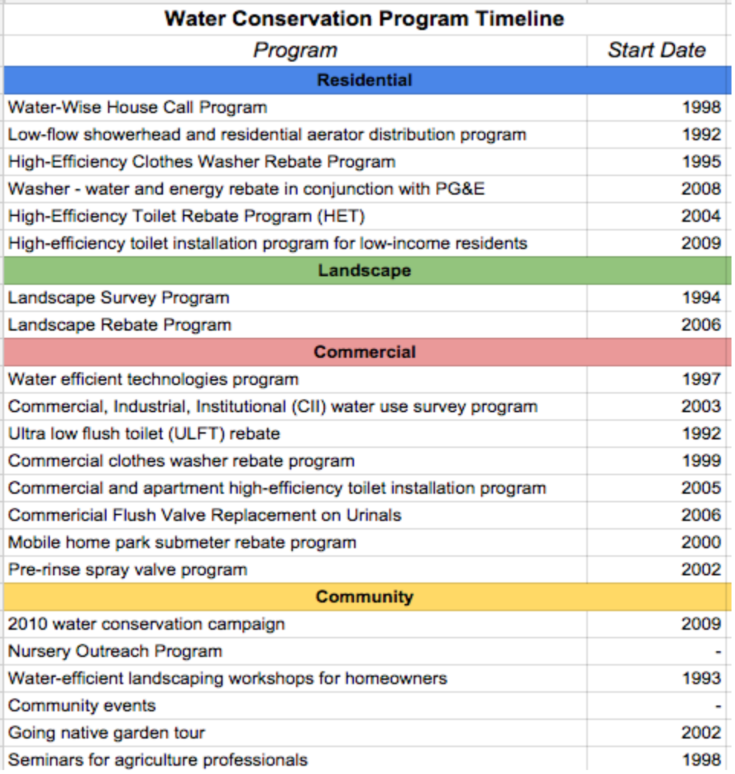
	Status-Quo	*New Proposal #1*	*New Proposal #2*
Cost-effectiveness – Consider total Savings / Total Costs	**SCORE:** (Our team developed a scoring system for each category using specific metrics and justification)	**SCORE**	**SCORE**
Impact – aggregate #s -Total Savings by program * -Total Participation by program	**SCORE**	**SCORE**	**SCORE**
Scale – Participation rates (how can we scale up our top programs, by retailer) divided by number of households in the retailer district.	**SCORE**	**SCORE**	**SCORE**
Total:	SCORE	SCORE	SCORE

Ultimately, our team considered aggregate scores for each policy and weigh additional criteria that might not be encapsulated in the three variables above. This analysis guided our final policy recommendation.

Program Results by Cost-Effectiveness

Our team began with the analysis of "cost-effectiveness" by employing a marginal calculation loosely based off of Brown's rule (see Section 4.2.1 above for more information). Table 5 below shows all the active programs although we only examine ten.

Table 5: Program timeline (programs organized by start date)



Water Conservation Program Timeline	
Program	*Start Date*
Residential	
Water-Wise House Call Program	1998
Low-flow showerhead and residential aerator distribution program	1992
High-Efficiency Clothes Washer Rebate Program	1995
Washer - water and energy rebate in conjunction with PG&E	2008
High-Efficiency Toilet Rebate Program (HET)	2004
High-efficiency toilet installation program for low-income residents	2009
Landscape	
Landscape Survey Program	1994
Landscape Rebate Program	2006
Commercial	
Water efficient technologies program	1997
Commercial, Industrial, Institutional (CII) water use survey program	2003
Ultra low flush toilet (ULFT) rebate	1992
Commercial clothes washer rebate program	1999
Commercial and apartment high-efficiency toilet installation program	2005
Commericial Flush Valve Replacement on Urinals	2006
Mobile home park submeter rebate program	2000
Pre-rinse spray valve program	2002
Community	
2010 water conservation campaign	2009
Nursery Outreach Program	-
Water-efficient landscaping workshops for homeowners	1993
Community events	-
Going native garden tour	2002
Seminars for agriculture professionals	1998

Source: Data provided by Santa Clara Valley Water District

We analyzed cost-effectiveness by *program*, as opposed to by *retailer* or *over time*, because a programmatic analysis has the fewest confounding variables. Cost-effectiveness by retailer can be difficult to determine given the vast differences in retailer population (some serve large metropolitan areas and therefore can possess economies of scale; others have smaller populations). Moreover, our “Water Savings” data was limited to time-series and programmatic data; we were unable to obtain retailer data for cost.

Our analysis separated costs into “fixed costs” and “marginal costs.” Our team noticed that *fixed costs* were largely absent from our active programs calculus, but very important in the passive program analysis. We also considered per unit utility costs, the size (or scale) of the program in terms of customers, and the resulting total costs.
We returned to Brown’s rule for our *Efficiency quotient*, which can be measured as **Cost - Effectiveness = Output/Input = Total Savings/Total Costs (in AF/$), where Total Costs = Participation * Per Unit Utility Cost.**

Using this methodology, our team found and ranked the programs from most to least cost-effective (Table 6). In another hand, utility costs vary tremendously from program to program, so we measured *efficiency*, as opposed to cost-efficiency, by dividing total savings by total participation to hold utility costs constant. In an ideal world where SCVWD does not have to worry about program costs, the programs can be ranked according to their water savings per unit (Table 6). These results are also illustrated in Figure 21, the latter ranking programs left to right from most to least *cost-effective.*

Table 6: Cost-effectiveness and Efficiency by Program

Cost-Effectiveness by Program		Efficiency by Program	
1. Residential Showerhead	0.0264	1. ITAP	3.78
2. Aerator Retrofit	0.0119	2. CII Clothes Washer	0.34
3. Pre-Rinse Sprayers	0.0056	3. CII Pre-Rinse Sprayer	0.28
4. ITAP	0.0035	4. Residential HET	0.23
5. Residential HE Toilets	0.0018	5. Residential Clothes Washer	0.11
6. Residential Clothes Washer	0.0017	6. Residential Survey	0.1
7. Water Survey/WWHC	0.0012	7. Residential Turf Removal	0.083
8. CII Clothes Washer	0.001	8. CII HE Toilet	0.08
9. CII HE Toilet	0.0003	9. Residential Showerhead	0.079
10. Residential Turf Removal[2]	0.00011	10. Aerator	0.004

Source: Data provided by the Santa Clara Valley Water District

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[2] This program saves money itself and is far more than just a survey. Survey participation results in savings according to SCVWD because real equipment changes happen during the calls. During the calls, contractors go in and change the flapper valve, change the faucet aerators, change the showerheads. So this program, though described as a survey, does save money

[2] One important note about all our residential turf replacement program data is that we estimated numbers based on its cost-efficiency and amount of water saved. To calculate the number of squared feet replaced, we divided total water savings by .00011 water savings per squared foot. Then, we multiplied this number by the average turf size for each household in the county (1,500) to estimate the number of households that participated.

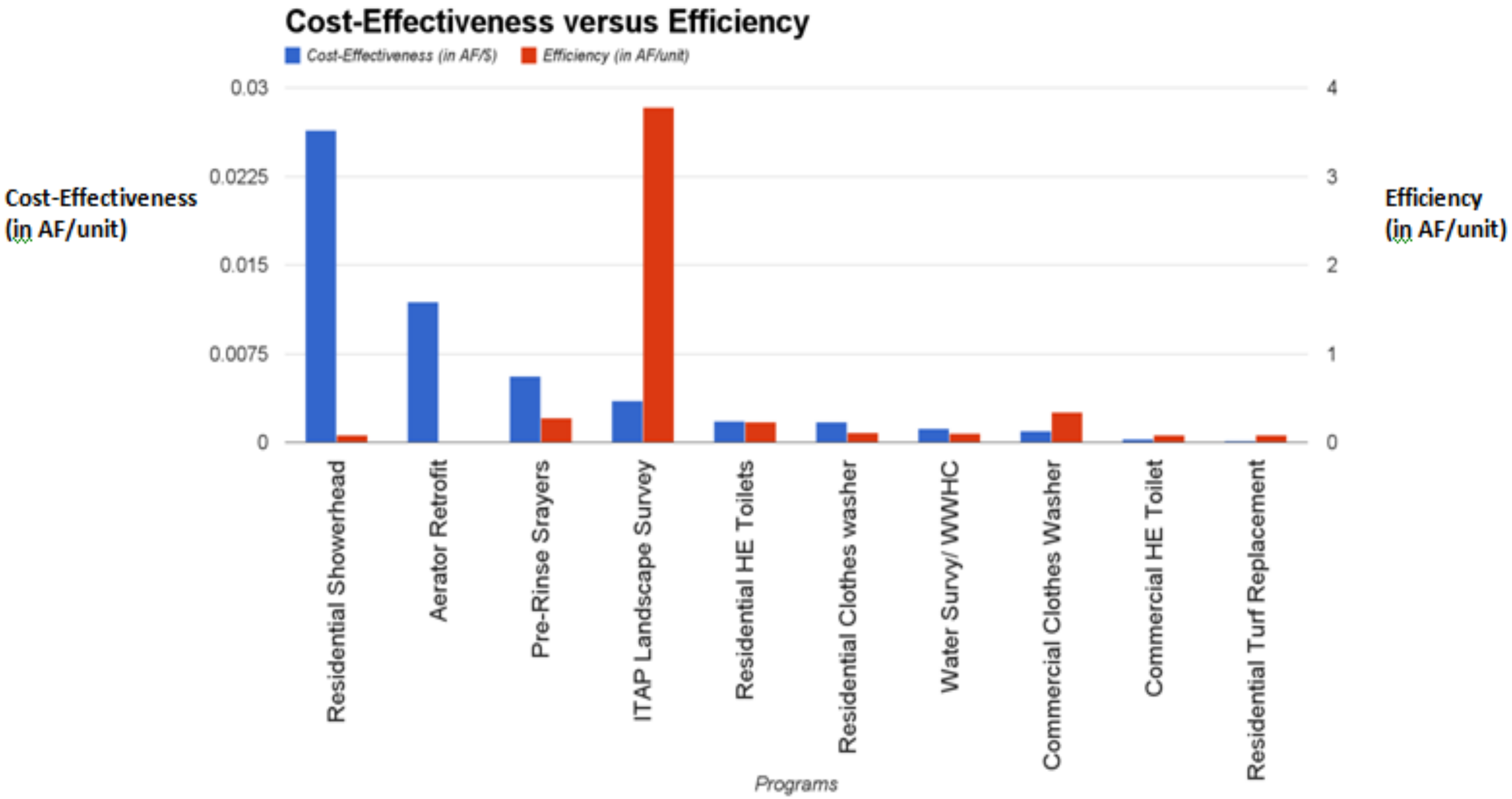

Figure 21: Cost-effectiveness (in Acre-feet / $) vs. efficiency (in Acre-feet / unit) by program
Source: Data provided by Santa Clara Valley Water District.

Table 7: Cost-effectiveness and efficiency calculations by program

Class	Program Name	Total Savings (AF)	Utility Costs, Initial Variable ($/unit)	Total Participation	Total Costs	Efficiency = Total Savings/Participation (in AF/unit)	Cost Effectiveness = Output/Input = Total Savings/Total Costs (in AF/$)	Data Available
Residential, SF	**LF Showerhead**	3025.239249	$3.00	38,176	$114,528	0.079	0.0264	1993-2012
Residential	**Aerators**	325.6787882	$0.35	78,227	$27,379.45	0.004	0.0119	2004-2012
CII	**CII Spray Rinse Valve**	742.823407	$50.00	2668	$133,400	0.28	0.0056	2002-2005
Irrigation	**Landscape Surveys**	1604.093251	$1,078	424	$457,072	3.78	0.0035	2003-2008
Residential, SF	**Residential HE Toilets**	3533.819583	$132.00	15,043	$1,985,676	0.23	0.0018	2004-2012
Residential, SF	**Residential HE Washer**	16056.65064	$67.00	144,445	$9,677,815	0.11	0.0017	1995-2012
Residential	**Residential Surveys, SF**	1934.26146	$84.00	19,666	$1,651,944	0.1	0.0012	2004-2012
CII	**CII Laundromat**	1122.241009	$355.00	3,305	$1,173,275	0.34	0.001	2000-2007
CII	**CII HE Toilet**	474.9788829	$269.00	5,911	$1,590,059	0.08	0.0003	2004-2008
Residential	**Turf Removal**	497.2978447	$750.00	6,028	$4,520,889.50	0.083	0.000111	2006-2012

Source: Data provided by Santa Clara Valley Water District

Cost Effectiveness - Implications and Analysis

Our team considered the relative cost-effectiveness of each program above. The order illustrates which programs provide the greatest water savings (in Acre*Feet) at the least cost (in $). We also calculated a list based on efficiency, which illustrates which programs provide the greatest water savings (in Acre*Feet) per unit. As shown in the graph, cost-effectiveness is not correlated with efficiency. Many of the programs we focused on perform well in efficiency but only averagely in cost-effectiveness, and this is primarily due to high costs. Based on our findings, we have compiled the following analysis:

- *Residential Showerheads and Aerators*: these programs are significantly more effective primarily because of their low costs. Showerheads cost just $3 apiece, and aerators $0.35 apiece, so the cost-effectiveness of these programs may be overstated. Indeed, holding utility costs constant, showerheads and aerators are the least efficient at saving water, with showerheads saving just .079 AF per unit and .004 AF per unit. Otherwise, the relatively minimal costs these units pose to SCVWD should be capitalized on to expand showerhead replacements until the program reaches saturation levels in the housing market.

- *Residential HE Toilet and Clothes Washer*: of the residential programs, these programs perform at the top, surpassing residential showerheads and aerators in efficiency. Due to their high costs, however, they perform lower in cost-effectiveness. It is also important to note that the clothes washers program has the greatest total participation rate and thus total cost, which could explain it being lower on the list of cost-efficiency. Reducing the cost of retrofitted toilets and clothes washers can thus greatly increase the cost-effectiveness of these programs.

- *Residential Survey*: as noted above, this program is more than a survey and experiences costs because of equipment changes, such as new showerheads, flapper valves, and dye tablets to detect leaks. To reduce program costs, SCVWD can partner with and contract out to its retailers, as it does in San Jose. In the long run, an automated metering system can also help reduce the costs of these water audits by centralizing information to SCVWD's retailers through improved data collection and information technology.

- *CII Clothes Washer Program*: this program performs among the highest in efficiency but among the lowest in cost-effectiveness due to high unit costs. As with residential HE toilets, residential clothes washers, and ITAP, SCVWD can increase the cost-effectivness of these programs by finding ways to decrease costs.

- *CII HE Toilets*: this program is the least cost-effective program we measured; our team suggests directing investments from this program to other programs. It is important to remember, however, that cost-effectiveness is only part of the larger picture. If CII HE Toilets score positively on the *impact* and *scale* criteria, then the high program cost might be worth the water saved in impact. In fact, should the impact and scale be large, the program may be necessary and salient for the District's overall water conservation. SCVWD may also have reputational incentives to partner with companies to provide CII HE Toilet rebates.

- *Residential Turf Removal*: this program proves to be one of the most costly of the SCVWD rebate programs we looked at, yet some of the greatest water savings potential can be realized here given that a large proportion of households' water use comes from lawn maintenance.

In addition, it is important to note that the comparisons and analysis our team made were based on analytical assumptions. Data for total savings and participation (and thus total costs), for instance, are available for 1993-2012 for Showerheads and for just 2003-2008 for ITAP. The availability of our data varies by program and by year. Additionally, we assumed total costs based on 2011 utility costs when utility costs change from year to year. Constraints aside, our data attempt to show an overall pattern of cost-effectiveness.

Program Results by Impact

In our "impact analysis," our team examined the aggregate effects of top programs at the district level. To calculate impact, our team took the total savings (in Acre-feet) as a cumulative figure. We chose cumulative savings because they represent the aggregate impact over time rather than the marginal or per drop impact. Therefore, we use cumulative total savings for each program.

To find our impact measure, our team then integrated the total savings equation with respect to *participation*. In effect, this gave us the area under the curve of a graph with "total savings" on the y-axis and "participation" on the x-axis. Finding this integral gave us the *aggregate* impact as it relates to participation rates. Diving our impact score by the number of years the program has been in existence provides a yearly impact score.

Impact = ∫(Total Savings = ∑(Savings per year)participation
Impact = (Total Savings)*(Participation rate)
Impact = (Acre Feet / Person)*(Numer of People)
Yearly Impact = (Impact) / (Years of Data)

Impact – units are therefore in Acre Feet

Using this analysis, our team developed results for "impact" by program in Table 8:

Table 8: Yearly impact calculation by program

Program	Years of Data	Total Savings (AF)	n s)	Yearly Impact (Customers*AF)
Residential Washer	**18**	**17,664**	**119,028**	**116,804,354**
Showerhead	**9**	**6,675**	**21,715**	**16,104,873**
Comm HE toilet	**8**	**2,406**	**22,805**	**6,857,810**
Residential HE	**9**	**4,620**	**12,503**	**6,418,655**
Water Wise	**9**	**2,719**	**21,144**	**6,387,978**
Pre-Rinse Sprayer	**11**	**4,782**	**4,298**	**1,868,291**
Aerator Retrofit	**9**	**551**	**20,541**	**1,256,462**
Comm Washer	**13**	**2,744**	**3,871**	**817,109**
Landscape Survey	**10**	**4,712**	**741**	**349,127**
Residential Turf	**8**	**497**	**3,014**	**187,352**

Source: Data provided by Santa Clara Valley Water District

Our impact analysis shows that the Residential Clothes washer program is unequivocally the highest-impact program. Its water savings are spread out among a large portion of the population. In fact, the clothes washer program has both the largest savings and the highest participation in the district. By contrast, the landscape rebate program serves few in the district, but nonetheless saves a good deal of water; this makes sense because each landscape intervention (like a yard) likely savings more water per person. Yet for impact analysis, we considered the *number of people* reached. Successful programs, we argue, engage many district residents and save cumulative amounts of water at the same time.

In quantifying impact, we wanted to take into account both the total savings from each individual program as well as their engagement of the local community. This is not a traditional metric, but we thought it was important to reward a program for its impact on increasing awareness regarding water conservation. Clearly, the Residential Clothes washer program has been by far the most impactful program due to both its significant water savings and its vast utilization. Not surprisingly, the Landscape Survey has the lowest impact due to the low utilization. However, what is very interesting is that neither significant water savings nor high utilization alone correlated to a higher impact score. For example, the aerator retrofit had over 20,000 participants, but it was still ranked significantly below the Residential HE toilet program, which has only 12,503 participants. On the other side, the pre-rinse sprayer program ranked below programs such as the water wise households even though it had almost twice as much total water savings. However, delving further, this disparity makes sense. The programs that are the most efficient in terms of savings are usually more expensive items than the programs that are highly utilized by the public. This makes programs like the Residential Clothes Washer program so interesting and important because it clearly was able to bridge that disparity and deliver a significant impact in terms of water conservation.

Program Results by Scale

In our "scale" analysis, we considered the *participation rates* of each of these programs relative to the district's overall household population. Since we focused on households, we only examined residential programs in this section. As a result, our participation rates aim to showcase potential for *expansion* and *improvement* for the district's most successful programs. Given the diminishing marginal returns for future customers, our team used the "*Scale*" measurement to determine which successful programs are most easily scalable to conserve more water in the future.

To develop scale, our team uses the following methodology:

Scale: (Total participation rate, in Units) / (# of Households in SCVWD)
Scale: (Total participation rate) / (589,172 households)

Scale: Units are (# of households/showerheads/calls per household)

Table 9: Participation rates for residential programs

Residential Program	Participation	Households	Participation Rate
Clothes Washer	144,445	589,172	24.52%
Aerator	78,227	589,172	13.28%
Showerhead	38,176	589,172	6.48%
Water Wise	19,666	589,172	3.34%
High Efficiency Toilet	15,043	589,172	2.55%
Residential Turf Replacement*	3,014*	401,229	0.75%

Source: Data provided by Santa Clara Valley Water District

In calculating scale, we wanted to measure the participation rate of each program as a percentage of the potential upgrades in the district. Participation is measured by the total number of rebates/units across all the water retailers in the SCVWD. Participation numbers for the Water Wise House Call program are deflated because San Jose Water Co. conducts their own water audit, which are not included in these totals. In addition, the aerator and showerhead programs have deflated participation numbers because we are missing retailer data before 2004. We acknowledge that number of households may not be the best denominator for all residential programs we analyze, such as for high efficiency toilets because a household may have multiple toilets; however, we used number of households as a proxy for the total number of possible upgrades in the district.

Based on our calculations, almost a quarter of all households in the SCVWD have participated in the clothes washer rebates. On the other end, less than three percent of all households have participated in the high efficiency toilet rebates. While the district has done a good job of incentivizing upgrades in high efficiency clothes washers, the other programs have more potential to scale up and increase water savings in the district. One limitation to this scale up analysis is that these participation rates are based on active program participation. If household residents upgrade equipment on their own, such as by buying a new efficient showerhead from the store instead of receiving a free one from their water retailer, then this upgrade is not taken into account in the participation totals.

Given this limitation, the number of potential households that need upgrades diminish and the participation rates would increase. This limitation may affect some programs more than others since people may invest in small changes like aerators on their own, but are less likely to do so with large purchases like clothes washers. Overall, these participation rates give some insight into which programs have a lot of potential for scaling up.

Synthesis of Status Quo

Given our analytical work in finding cost-effectiveness, impact, and scale, our team then inputted these measurements into our "conservation and efficiency rubric" developed earlier in this report. Our results are seen in Table 10:

Table 10: Status-quo program rankings in cost-efficiency, impact, and scale

	Status-Quo	*New Proposal #1*	*New Proposal #2*
Cost-effectiveness – Consider total Savings / Total Costs	**Residential LF Showerhead, SF – Most Effective Program with .0264. Rank = 1.** **High Efficiency Toilets is the least cost effective, at .0003. Rank = 9.**	**SCORE**	**SCORE**
Impact – aggregate #s -Total Savings by program * -Total Participation by program	**Residential Cloths Washers has the highest Impact with 2102478368.** **Rank = 1.** **Landscape Survey has the lowest impact (3491272);** **Rank = 9.**	**SCORE**	**SCORE**
Scale – Participation rates (how can we scale up our top programs, by retailer) divided by number of households in the retailer district.	**High Efficiency Toilet has the most potential; current impact is 2.55%.** **Rank = 1.** **Residential Clothes Washers has the *highest current* scale; 25.52%;** **Rank = 9.**	**SCORE**	**SCORE**

Table 11: Total Average Score in Water Conservation and Efficiency, as measured through cost-effectiveness, impact, and scale.

Program	Cost-Effectiveness	Cost-Effectiveness Score	Impact	Impact Score	Scale (for residential programs)	Scale Score	TOTAL AVG SCORE (Lower Score = better program)
Showerhead	**0.0264**	**1**	**116,804,354**	**2**	**6.48%**	**5**	**2.66**
Residential HET	**0.0018**	**5**	**16,104,873**	**4**	**2.55%**	**2**	**3.66**
Residential Washer	**0.0017**	**6**	**6,857,810**	**1**	**24.52%**	**6**	**4.3**
Pre-Rinse Sprayer	**0.0056**	**3**	**6,387,978**	**6**	**N/A**	**N/A**	**4.5**
Aerator Retrofit	**0.0119**	**2**	**6,418,655**	**7**	**13.28%**	**5**	**4.7**
Water Wise	**0.0012**	**7**	**1,868,291**	**5**	**3.34%**	**3**	**5**
Comm HE toilet	**0.0003**	**9**	**1,256,462**	**3**	**N/A**	**N/A**	**6**
Landscape Survey	**0.0035**	**4**	**817,109**	**9**	**N/A**	**N/A**	**6.5**
Residential Turf	**.00011**	**10**	**349,127**	**10**	**.075%**	**1**	**7**
Comm Washer	**0.001**	**8**	**187,352**	**8**	**N/A**	**N/A**	**8**

Potential Limitations and Challenges

In this section, our team describes challenges for individual residents to participate in active programs and for SCVWD to implement passive programs.

Challenges

Individual barriers for water conservation and efficiency: For individuals living in the SCVWD, there are hurdles that limit engagement with water conservation. Some of these hurdles are normative; individuals prefer not to conserve water or participate in conservation discourse because they do not believe that it is an important issue. Some SCVWD residents will work to conserve water even at their own economic cost. In other cases, incentives do not properly align to motivate concerned individuals towards action.

- *Collective action problem:* As Fane and Patterson note in their report on "Urban Water Planning in the Face of Climate Change," the scale of water conservation in general, and California's drought specifically, is daunting for individuals.[16] Therefore, many individuals might feel that their individual actions cannot change or shape a larger problem. As a result, it might be difficult for SCVWD to convince individuals to change behavior purely from a normative perspective. Our team hopes to further delve into what barriers shape the collective action problem and how it can most effectively be overcome.

- *Logistics of the rebate process:* Some SCVWD residents struggle to navigate the sheer logistical barriers inherent in participating in a rebate program. Filling out the forms and providing all of the appropriate documents in order to be granted a rebate can be challenging. This is especially true for lower income Santa Clara Valley residents, many of whom might not speak English as their first language. The process of participating in a rebate program might seem daunting to residents, and rebates that require filling out forms and providing paperwork may deter wider participation.

- *Long payback period and return on investment:* Due to a relatively low price of water in comparison with more expensive renovations, SCVWD residents see a full return on costly initial investments. It can cost thousands of dollars, as much as $10,000, to replace a lawn with xeriscape or with artificial turf; the rebate from SCVWD for this program is merely $750.00.[17] If residents save $20 to $40 each month on their water bill, it requires many months or even years to make these active programs economically efficient for the consumer.
- *A note on the process to navigate state permitting:* One might think that California's state permitting process, which is usually done by contractors and not by residents themselves, is also challenging. Preliminary investigation indicates satisfaction with navigating

permits and working with California's state code. That code is, by necessity, very general, and contractors received good reviews in customer survey data. Says one customer: *"This is a great program and the survey report the contractor, did was WAY above expectations. He was detailed and the value for this program is exceptional because he really knows his stuff."*[18] Permits are often required for larger interventions, like opening a wall or replacing plumbing. Yet contractors seem to work quickly and efficiently when navigating permits; residents filling out forms for rebate programs and requesting contractors in the first place seems to present a greater challenge. Says one commercial building owner, surprised by the ease of easily getting permits from a contractor: *"The entire process happened more quickly then I had anticipated. Overall I was pleased."*[19]

- *Lack of awareness about water conservation:* Some individuals might not know about the various water conservation programs SCVWD offers. Indeed, only around 32,000 households participated in some type of active conservation program in the District,[20] while there are over 600,000 households in Santa Clara County alone.[21] A good number of the 550,000+ households that do not participate in water conservation programs might simply not *know* they exist or that they qualify. Survey data from SCVWD show that most customers who do participate in programs hear about water conservation from a variety of different sources. In the case of High[22] Efficiency Toilets (HETs), most rebate customers heard about the program through letters or through their water bill.[23] Yet in the case of Landscape Rebates, most customers heard about the program through friends, family, or word of mouth.[24] In nearly all cases though, customers are satisfied with the rebate and advertising programs. In the case of the Landscape Rebate Program, over 65% of customers found it to be "excellent," and such trends occur throughout the rebate programs.[25] Since SCVWD residents who *do* know and participate in the programs *like* them, how can the district expand the tent and bring more people into these programs?

- *Normative opposition*: Though our team did not study the notion of "normative opposition" explicitly, we expect that a small subset of SCVWD residents will simply be opposed to water conservation on the grounds of their own values. Such values might include limited government or a value of liberty in the ability to use as much water as one pays for. In **Appendix One**, our team offers a survey instrument that aims to determine what proportion of SCVWD residents who are *not* participating in conservation programs have chosen to do so out of philosophical reasons rather than because of awareness or logistical barriers in time and money. Our team recognizes that some individuals will never participate in a conservation program despite the publicity campaign or the economic incentive structure. For these residents, a policy of "water rationing" or physical quotas on water use might be the only way to conserve water, although such policies might not be very popular.

- *Financial barriers*: For some customers, conserving water is something that is desired but is expensive to participate in, and water conservation is not a top priority. Our **Appendix Two** survey instrument asks all participants about their average annual income in order to analyze whether water conservation is a financial luxury unavailable for all. For some residents, replacing an outdated washing machine with an efficient washer (through the SCVWD "Residential Clothes Washer Rebate Program)[26] can be costly, even with a SCVWD rebate. Landscaping is an even costlier process; many lower income SCVWD residents might not have lawns at all, and if they do changing a lawn's water usage can be costly. Writes one survey participant from the Landscape rebate program: "Nearly half of my front yard was excluded from the rebate calculation for no reason; we installed water efficient landscaping for the entire front yard, not just part of it. As a result we received far less of a rebate than which we were led to believe."[27] To what extent does the *amount* of a rebate play into decision-making? Are rebates meant to actually incentivize lower-income customers? Our team seeks to investigate how SCVWD can make water rebates economically viable and in fact *preferred* for the greatest number of people.

Residential, Commercial, Industrial, Agricultural: Although most water usage in SCVWD comes from residential sources, our data include information about passive and active program opportunities in residential, commercial, industrial, and agricultural sectors. Therefore, our team will consider all of these sectors as we recommend programs that are most effective and that can change most efficiently.

Diminishing Marginal Returns: Diminishing marginal returns are a challenge with both passive and active programs, but particularly with passive programming. SCVWD will be able to improve water usage by first fixing the largest, most glaring inefficiencies in the District's infrastructure portfolio. More specific projects will inevitably be both more costly and lead to smaller gains in water conservation.

Like with passive programs, active programs also suffer from the challenge of diminishing marginal returns. The most water conscious and willing customers will be the first to participate in any conservation program; building out beyond that is a challenge. Eventually, the only customers left are those with more economically inelastic preferences. Even a large rebate or larger incentives might not push certain customers to change behavior, and ever more innovative action is required. The *greatest declines* in water usage occur where the "lowest hanging fruit" lies; moving forward, customers must be ever-more motivated to take action.

6. BEST PRACTICES ANALYSIS & ALTERNATIVE SOLUTIONS

Along with the San Francisco Public Utilities Commission (SFPUC) and the Municipal Water District of Orange County (MWDOC), SCVWD is at the forefront of water conservation and efficiency. This section provides a brief overview of SFPUC's and MWDOC's water conservation and efficiency efforts to place SCVWD's efforts into context, and later delves deeper into a successful program (automated water meters) as a potential program to be replicated in SCVWD. Overall, there are many general similarities among SCVWD, SFPUC, and MWDOC in terms of services provided with regards to education initiatives, campaign awareness efforts, and rebate programs.

San Francisco Public Utilities Commission

In San Francisco, residential water use is 49 gallons per capita per day on average as opposed to 100 statewide. Gross water use is about 88 gallons per capita per day (gpcd), less than half the statewide average of 197 gpcd. In 2007, San Francisco Public Utilities Commission's (SFPUC) call for voluntary cutbacks effectively reduced overall water consumption by 12%, exceeding the goal of 10% and avoiding mandatory rationing.[28] Last year, SFPUC set another 10% reduction goal to cut water use voluntarily by capitalizing on existing active programs.[29]

It is important to note that although San Francisco's water use rates are impressive, the population density of San Francisco greatly affects water use. Since more dense living features do not have *lawns* or *landscaping uses*, high-density regions have lower rates of water use. Lawns can account for up to 65% of residential water use, and usually account for over 30% of total water use.[30]

Passive programs: The SFPUC has taken efforts to increase the use of more efficient water technology in retail and civic areas, implementing high-efficiency toilets and high-efficiency washers within commercial and institutional properties. The average unit cost for non-residential sector is higher than the residential sector because it includes incentives for large landscape and other indoor retrofits that are considerably more expensive than basic residential plumbing fixture replacements, but investments made in bulk reduce the cost per unit. Additionally, the SFPUC's new headquarters in Civic Center boasts a "living machine" that uses on-site biological wetlands to treat sewage and gray water that is then used for toilet flushing in their building, reducing water use by 60%.[31] If the SCVWD is considering different long-run development plans, such infrastructural improvements offer promising models to follow.

Active programs: To help residents be more cognizant of their water use and encourage greater participation in programs, the SCVWD has adopted measures including drought campaigns that market water conservation as “smart and sexy”[32] These ads have shown up as television commercials and ads on newspapers, bus shelters, buses, and billboards. Ads are also translated in Chinese and Spanish to reach a broader population in the city. SFPUC also advertises the latest trend as “Brown is the New Green,”[33] an awareness campaign that SCVWD introduced, and has increased economic incentives in rebate programs to attract greater participation.

Among its water conservation and efficiency efforts, SFPUC has also implemented an online tracking tool for users using data from WaterSmart Software, a system we conduct a closer analysis of later on. With the online tracking tool, SFPUC collects detailed water use information now included when people log in to their SFPUC accounts online, and the website shows customers when they used the most water and how much, in gallons instead of water units, to better help people understand their water use and manage it better.

Municipal Water District of Orange County

The Municipal Water District of Orange County (MWDOC) is a wholesale water supplier and resource-planning agency that serves 28 retail water agencies throughout Orange County.[34] In 2013, the MWDOC approved a Master Plan to pursue cost-effective water use efficiency activities that will reduce per capita water consumption by at least 20% by 2020.[35] The Plan is estimated to save enough water to supply nearly 13,000 single-family homes per year, or 4,300 acre-feet per year. Costs of implementing the Master Plan are estimated to be just $14.6 million, while benefits to the county are estimated to be approximately $47 million dollars.

Active programs: Like SCVWD, the MWDOC provides educational resources, creating for instance an online educational tool for kids to learn about water conservation. The tool features an educational portal for K-5th graders, 6-8th graders, 9-12th graders, post secondary students, and teachers, linking the latter group to water resource education materials and training workshops. Similar to SFPUC, MWDOC also collects water use information via the Internet through local water districts. For instance, through the Orange County Water District (OCWD), the MWDOC offers free water saving programs such as an industrial program, landscape program, and public spaces program, and program participants can track their irrigation meter’s monthly water use online and identify areas that are over and under watered. A recent study showed that irrigation meters participating in the landscape program save an average of 765 gallons of water per day compared to meters not part of the program.

Based on our conversations with SCVWD, we then decided to narrow our best practices analysis to a specific program we found has been successful in SFPUC and MWDOC and could be implemented in Santa Clara through SCVWD’s retailers: the automated water meters system.

Automated Meters

In researching SFPUC and MWDOC's water conservation and efficiency efforts, we continuously came across the usage of automated water meters to more efficiently track water savings, a technology that SCVWD could implement to better collect data for both customers and the wholesaler. Automated water meter systems reduce operating costs for meter reading and billing and improve customer service through frequent collection of more precise water consumption data from installed WaterSmart meters. Because they are self-automated, they reduce vehicle emissions associated with meter readings and service calls to free up employees for other work. Ultimately, the technology allows for quicker and more accurate identification of high usage and suspected leaks, benefiting both customers and the retailer or wholesaler. Customer service representatives have access to more frequent and accurate water consumption data, while improved meter reading ability improves billing estimations. Additionally, better collection of data allows the retailer or wholesaler to more easily reach demand management goals by tracking water savings more accurately for future analysis of water conservation and efficiency efforts.

Currently, Marin Municipal Water District (MMWD) has applied for a pilot program with Smart Irrigation, which will be completed within 18 months of the start date. Seeking to achieve 25% reduction in average landscaping water use through SMART irrigation equipment and Automated Metering Infrastructure (AMI), MMWD will implement 800 irrigation water meters at 800 sites and hopes to reduce commercial landscape sector potable water consumption annually by 300 AF to increase safe drinking water for other uses. Currently, MMWD has 117 commercial irrigation landscape water meters and 2,294 mixed indoor/outdoor residential landscape water meters. New and improved Smart meters will record water consumption data on hourly basis that will be entered into MMWD's computer system. Each automated meter and transmitter costs $210 per unit.[36] In terms of long-term funding, MMWD's water smart system will need upkeep and replacement over a 15-year lifetime. Future capital expenses for AMI/AMR hardware and software replacements and upgrades will come from MMWD's capital improvement budget, while irrigation customers will be responsible for costs of maintaining and replacing irrigation equipment at their sites as required.

Given the clear benefits to water conservation and efficiency of automated water meters, SCVWD is on the right path partnering with WaterSmart and other companies to implement a similar pilot project. WaterSmart Software has been shown to have effectively reduced water use, particularly when paired with forms of customer engagement. In the East Bay Municipal Utility District (EBMUD) Pilot of WaterSmart Home Water program, for instance, EBMUD provides a customized water use report to households based on data collected from smart meters. These reports include specifically tailored suggestions for cutting back water use, such as checking for leaks, conducting a home survey, or replacing grass with low-water using plants.

The unit cost of saved water ranged from $250 to $590, and households in the Pilot's program were 2.3 times more likely to participate in one of EBMUD's rebate program.[37] Recently, EBMUD just enrolled its 50,000th customer in its My Water Report program and will continue to expand its WaterSmart program to reach over 100,000 customers because it has been so successful. In moving forward with WaterSmart Software, SCVWD can draw from EBMUD's best practices and see how MMWD's system will play out.

The WaterSmart Program is so successful at changing norms because the billing tracks customer's usage relative to neighbors. (The program tracks usage compared to a neighborhood general average, and further to energy-efficient neighbors.) Transparency itself is a huge tool, especially when linked to hyper-local comparisons. Social norms are often dictated by what the neighbors are doing.

Our examination of the automated meter program highlights, through a case study, one of several key best practices. We believe that SCVWD is on the right path in cost-sharing with its retailers on water smart technology to implement a similar pilot project. Although our team focused on the automated meter systems as a case study, there are countless other programs that operate in multiple district and in very similar ways; sharing best practices across districts and across many different programs will surely lead to new, innovative ideas and the sustaining and expansion of existing practices.

Alternatives Analysis

After analyzing the current programs and activities of SCVWD and providing future projections, our team considered the future impact of program alternatives. Our team considered enhancing or reducing certain programs and activities. Some actives (either passive or active) are not currently reaching their maximum potential audience; enhancing these programs might more effectively curb water-use. Likewise, some programs and activities might be overused. Below, our team considered eight potential alternative interventions justified through theory of why such interventions would make sense.

Ultimately, our team selected the two most effective interventions (as measured by our evaluative criteria) and compared them to the status quo. One alternative represents a smaller-scale, more conservative solution; the second alternative, a more dramatic one. Our alternatives aim to engage more SCC residents around water use and to change long-term behavior.

Below is a brief description of, and justification for, each alternative:

Expand the Tent

This alternative intervention seeks to bring new SCVWD customers into conservation programs both through surveys asking why certain district customers do not conserve water, and through pinpointed targeting of certain demographic groups in Santa Clara Valley. The intervention will often center on *expanding* programs, which are successful, but currently only affecting some SCVWD customers. For example, the 2013 Water Submeter program was installed by 374 customers, but was confined to use by just the San Jose Municipal and San Jose Water Company retailers.[38] Is there potential to expand the demographic tent and bring this program to more SCVWD residents? Or is the efficacy of this program confined to homes in San Jose, perhaps due to the city's higher density and multi-family homes?

It is important to note that "Expanding the Tent" refers to expanding water projects that work to new demographics and populations, *both for passive and active projects*. This allows for collaboration and engagement with new users directly, and through new passive projects that conserve water in new areas. Expanding the Tent can serve as an opportunity to reach part of the SCVWD population that might be *interested* in water conservation and efficiency but has not yet engaged actively in the district's active programs, for a number of reasons.

One method of expanding the tent that we touched upon earlier is to implement an automated water meter system that will allow SCVWD and its retailers to collect more accurate data of household water use. That data will then be used to send each individual household a personalized report outlining the most effective ways it can reduce its water use, such as replacing its lawn with drought-resistant plants or retrofitting a high efficiency toilet. With people more aware of how they can go about saving water, they are more likely (in fact, 2.3 times more likely according to statistics from EBMUD's WaterSmart Home Water program pilot) to participate in the rebate programs that SCVWD offers. There is much potential in reaching residential and commercial consumers not yet participating, and expanding the tent can help SCVWD tap into that potential to further its water conservation and efficiency efforts.

Changing Social Norms

This alternative practice considers ways to change long-term water use behaviors through education and engagement. The personalized household reports from an automated water meter system mentioned above can not only help expand the tent, but also change social norms by helping households be more cognizant of their water use. Another excellent example of a program or activity that works to change such norms is the "Water Wise House Calls" program.[39] Although SCVWD data effectively show *how many* homes have been called, and in what districts these homes are located, these data do not effectively show change over time.

Perhaps calling the same households over a longitudinal time interval (for example, phone calls encouraging conservation over a number of years) can effectively help change these norms.

It is important to note that it is extremely difficult to measure and evaluate activities geared at changing social norms, particularly around water usage. Even surveys asking residents how much water they use are not fully accurate. Examining water savings totals (available both by activity and by district and resident) is the best way to show water use changes.[40] These data can be regressed by a Bernoulli variable highlighting whether "water wise house calls," in the short or in the long run, change water use behaviors.

Economic Incentives

This alternative considers how new rebates and active techniques targeting consumers through demand-side incentives can convince customers to use less water. This strategy focuses most explicitly on expanding rebates and active programs that work. Given SCVWD's cost-sharing model in which it shares the cost of each program unit with its retailers and the state government, there is potential to leverage more funding to lower per unit utility costs and thus provide consumers with higher incentives. In evaluating the many programs focusing on economic incentives in the SCVWD (see page 3 of this report for a list of active programs) and considering which are the most successful, we found that programs that could benefit the most from lower unit costs and higher rebate amounts include: Residential HE Toilets, Residential Clothes Washers, ITAP, CII Clothes Washers, and CII HE Toilets. For rebate programs, we ask where is the "sweet spot" when it comes to size of rebate? One can consider the optimal rebate in light of cost-effectiveness, impact (amount of water saved per year), and scale (level with the largest number of interested participants). As the 2009 California Water Plan illustrates, water rates do affect consumer behavior (when they are passed down to the consumer and not just felt by direct retailers), as do rebates on water efficient technologies.

Legal/Regulatory Policy Change

Changing rules at the level of public policies, whether through local ordinances or statewide mandates, can force curbed water use. Is it effective for SCVWD to commit resources to advocacy? Our team concludes that the fluidity of advocacy's effectiveness renders its ultimate utility unknown, especially since looking into the political climate and many coalitions surrounding this issue is beyond the scope of this project.

This alternative might be a good recommendation should the "expand the tent" and "economic incentives" alternatives result in an unfavorable analytical outcome. This might lead our team to conclude that, in order to cost-effectively change water use behavior, one must change the regulatory framework by which individuals use water. Although legal or regulatory change can be expensive (the cost of lobbying and advocacy), its effects on water use can be the most dramatic and predictable.

City managers can play a role in implementing policy changes by helping direct funds towards water conservation and efficiency efforts. If SCVWD for instance wants to pursue an automated water meter system, city managers can serve as proponents in their own cities for a pilot program and push for their city budgets to accommodate the program for the first couple of years. This will allow SCVWD to share some of the upfront capital costs of the program with cities until water savings exceed those costs. If SCVWD identifies certain improvements in infrastructure, ordinances, and zoning, it can also work with city managers to encourage cities to take on some of the infrastructural costs and change the necessary ordinances and zoning regulations.

In the long run, changing legal and regulatory rules of water use will increase impact and scale to a saturation point where further passive changes will experience diminishing marginal returns. It is then that active program changes will have the most effect, and our analysis focuses on what this effect might be.

Tiered Rates and Price Hikes

Our team examined data on sharable rates to consider the impact of changing water prices on water use and conservation. Although SCVWD is a water wholesaler, it is not in a position to control market prices unilaterally for the district's twelve retailers. The District needs to justify all price increases fully and must have them approved by their board. Raising prices is often unpopular with constituency groups, so many board members prefer not to raise prices. Does increasing the cost of water - whether across the board or for certain incomes or demographic groups - serve as an effective solution?

Tiered rates are an intriguing solution to the political controversy surrounding water rate hikes for conservation purposes. In general, water conservation efforts often suffer from the "Not In My Backyard" effect; communities agree that water conservation is an important issue, but they are unwilling to pay higher water rates to achieve conservation goals. By instituting a tiered rate system, SCVWD could keep rates constant for the vast majority of water consumers while only raising rates on the most egregious water users.

A tiered rate system would be effective for multiple reasons. First, consumers affected by tiered rates will respond to the price hikes by reducing their water usage depending on their willingness to pay. Since tiered rates will not affect the majority of the population, the expected effect of pure market forces may be limited. However, the implementation of a tiered rate system will certainly raise awareness of water conservation among the general public. Many consumers will begin to monitor their water use to ensure they will not reach the point of paying a higher rate. This may even lead to more water savings than the effect of consumers paying a higher rate for water.

Our team considered the possibility that water rate hikes will effectively be borne by consumers without any change in behavior. Such a result would be inefficient. Yet the additional revenue from water rate hikes could then be used to fund other alternative practices, like the active educational campaign, on a larger scale. Also, increasing the price of water is so cost effective it may even save SCVWD money.

Politically, this is significantly more palatable than an across the board rate hike. A suitable comparison is the current debate surrounding tax hikes on a national level. Over 68% of Americans believe that the wealthy pay too little in taxes while 60% believe the middle-class pay too much in taxes.[41] Therefore, a tiered rate system could be sold politically as making water usage prices "more fair" and having significant water users pay their "fair share".

However, one must consider the very limited scope of water price hikes, since dramatic rate increases are more likely to burden consumers and lead to backlash than to change behavior. Fines and fees for high water users might be more credible, but can also be highly regressive in nature, as larger families often also have lower incomes.[42] San Francisco's Public Utilities Commission currently *has* a two-tiered system of water rates, but the Commission is working to eliminate these tiers by 2018.[43] A National Science Foundation (NSF) working paper highlights the effects of tiered water usage using the price elasticity of water demand as a dependent variable. The study notes that while tiered water rates have expanded (from 4% of all U.S. water districts in 1982 to over one third in 2000), the "consumer responses to [tiered rates] are unclear, at best."[44] Also, the political difficulty of pushing through a significant water hike cannot be understated. Even if it affects a limited amount of the population, it still is often a politically unpopular move.

Given the limited scope of water price hikes, the unpopularity of pure fees and fines, and the political uncertainty around instituting a tiered rate system, our team would suggest other water saving strategies. However, a tiered rate system may be something for SCVWD to consider as a more palatable political solution than a pure rate hike in the future.

Rationing

Since our team found that "expanding the tent," working to change social norms, improving consumers' economic incentives, and targeted price hikes did not change water use, our team thought instead to investigate a far more drastic proposal: water rationing. A rationing proposal has perhaps the highest rate of success when it comes to curbing water use, but it is often employed at a hyper-local level.[45] If drought continues to get more extreme, or if curbing water use becomes a higher priority than economic efficiency or customer satisfaction, an outright ration might be most effective.

As we see in the Figure 1 on page 8, the 1987-1992 drought so effectively curbed water use because of the drought's extreme circumstances. During this period, aggregate water use actually *decreased* despite an increase in population, decreasing per capita water use significantly. Sometimes, physically restricting the supply of water is most effective. Figure 1 highlights (in yellow) the period from 1987-1992 where water use declined most dramatically.[46] The 1987-1992 decline in water use occurred as water rationing efforts literally forced residents to use less water. As we can see from Figure 1, the conservation efforts from 1992-2000 remained effective, perhaps because of the important rationing work done from 1987-1992.

Education and Enforcement

Last June, the Santa Clara Valley water board unanimously elected to spend $500,000 on five to ten "water educators" to monitor and enforce water use regulations.[47] These water educators focused specifically on high-use customers, but did not actually have the power to serve tickets. Instead, they used their position to "investigate claims, teach conservation, and report chronic water wasters to that person's water company."[48]

Such efforts help change social norms and economic incentives through specific, localized reminders. As mentioned before, another measure could be automated water meter systems that provide households with individualized reports on their water use. Yet because of the irreplaceable nature of human interaction, the presence of water educators might be a remarkably direct way to change end-user behavior and promote efficient water practices in and around the community.

Public-Private Partnership

As briefly mentioned before, within the SCVWD service area lies large tech companies like Google, Apple, Ebay, and Facebook. These companies pride themselves in being innovative and environmentally friendly.[49] As their campuses expand and remodeling plans surface, a public-private partnership between these large companies and the SCVWD has the potential to be a successful active water conservation initiative. As more and more workers in the region spend the bulk of their days in the office and companies begin to offer laundry and meal services, active programs aimed at efficiency and conservation in the business sector can have enormous influence.

7. RECOMMENDATIONS

Of our eight potential deviations from the *status-quo* activities and programs currently employed by SCVWD, our team considered and analyzed the two most compelling alternatives. Our methodology is as follows: our team considers path dependency and the current trends of water use and cost and project future metrics using regression analysis. We analyzed cost, aggregate water use in terms of impact, and the population's share of water use as a scale measure. We analyzed the *status-quo* activities in SCVWD along with two other alternatives. Ultimately, in light of our evaluative criteria and the trend lines we see, our team proposes a set of two program recommendations in light of different hypothetical possibilities.

The recommendations proposed below are deviations from the status quo. Our team believes that such deviations either save money, increase per capita rates of water conservation, decrease per capita water use, and/or can be scaled to include a large portion of the district's aggregate customer base. New programs below target new audiences who have yet to participate in SCVWD conservation programs, and work to change social norms around water usage. Of all of our proposed alternatives above, the following two advance our chosen evaluative criteria:

Recommendation #1: Expand the tent

"Expanding the Tent" is effective because it allows for the continued scaling and expansion of existing programs that work. Therefore, it is fairly cost-effective since the design and implementation of these programs have already occurred. It also makes use of programs that are well known to reduce per-capita water use. The *biggest* advantage to this recommendation, however, comes with the criterion of *scale*, as expanding the tents engages residents, commercial and industrial entities, and other SCVWD customers, around water conservation.

- Programs such as Residential HE Toilets, Residential Clothes Washers, ITAP, CII Clothes Washers, and CII HE Toilets tend to perform higher in efficiency than they do in cost-efficiency. This suggests that some of the most effective programs are also the most expensive, but it is these relatively more expensive programs that can be capitalized on in expanding the tent.

- Expanding the tent will involving enhancing the water conservation experience for customers who already participate and catering to those who do not. Our survey instrument (see **Appendix Two**) effectively illustrates ways for SCVWD to track and measure under-utilized demographic groups.

In order to most effectively expand the tent, SCVWD ought to examine the relationship between different demographic characteristics and rates of water use. Such characteristics can include income, geography, and single-family or multi-family home use. Analysis can then consider a "target audience" (or multiple such audiences) and the potential for increased savings.

- For instance, residential use is broken up into single- and multi-family, and clearly distinguishing between the two's water use trends may help SCVWD identify which population it needs to focus more of its awareness efforts on. Based on our impact analysis, for instance, the Residential Clothes Washer rebate program has so far offered the greatest benefits due to its significant water savings and vast utilization. Whether or not this phenomenon is driven by participation from single-family units, multi-family units, or both is unclear because we did not have participation data of both separately. More nuanced and agile targeting can save both money and water in the short-run and in the long-run.

Expanding the tent: effectiveness. What is the effectiveness of this program alternative? Our team will develop a "score" using our data for the metrics of cost-effectiveness, impact, and scale. We expect "expanding the tent" to be somewhat cost-effective, since the program skeletons and activities are already in place.

- Additionally, because the program skeletons are already in place, it may be easier for SCVWD to request for more grant funding. Because SCVWD cost-shares with some of its retailers and the federal government, it can draw from past water savings as evidence of effective water conservation to secure more funding from higher up. This will allow it to decrease its per unit utility costs for each program, increasing cost-efficiency. Programs that would benefit the most from additional funding are Residential HE Toilets, Residential Clothes Washers, ITAP, CII Clothes Washers, and CII HE Toilets.[50]

- Expanding the programs outward toward new demographics might also be fairly impactful when it comes to per capita water use, since new customers might be very willing to change behavior in light of new programs. The largest criterion that may change, however, is *scale.* "Expanding the tent" by definition scales up existing programs by diversifying activities throughout the district, leading to aggregate decreases in water use.

Recommendation #2: Changing social norms and long-term water usage behaviors through education and engagement

Education and awareness programming is a second potential alternative that can actionably work to decrease water use in a cost-effective and scalable way. Our team will consider this alternative because it represents a wholly different strategy than the "expand the tent" strategy or the “economic incentives” strategy that focus on consumer incentives in an economic framework. Given diminishing marginal returns on existing programs and the limits of a rebate’s efficacy, our team will argue that working to change long-run social norms and localizing the impact through education can actually have a larger effect (and a more cost-effective effect) on water usage.

Building off of initiatives from the SFPUC, MWDOC, MMWD, and EBMUD, one way to localize the impact of water and to educate customers is the implementation of an automated WaterSmart meter system and agile “personal account” system tracking water use not just of one’s own household but of one’s neighborhood and city.[51]

- SCVWD could contract out to technologies such as WaterSmart Software to collect data and send out personal reports to individual households (see Best Practices section). Furthermore, in another form of public-private partnership with local tech companies, SCVWD could collaborate with data and software corporations like Palantir in Palo Alto to identify areas of opportunity from the data collected as well as potential software improvements.

- Regardless of the implementation route, an automated water meter tracking system works to show one’s own impact in an issue often plagued by a collective action problem and incentivizes participation in water conservation and efficiency rebate programs at the individual level. Indeed, household participation in SCVWD’s Residential HE Toilets, Clothes Washer, Showerhead, and Aerator Retrofit Programs may increase significantly given that personal account holders in EBMUD’s WaterSmart Home Water Program are 2.3 times more likely to participate in EBMUD’s other programs. In our own survey instrument (see **Appendix Two**), we ask residents whether water conservation is a problem for others, their neighborhood, and their own household. A personalized account system can help to show each household’s role in water conservation.

Taking a nod from the SFPUC, one way to localize the impact of water and to educate customers is the implementation of an agile “personal account” system tracking water use not just of one’s own household but of one’s neighborhood and city.[52] Such a system works to show one’s own impact in an issue often plagued by a collective action problem. In our own survey instrument (see **Appendix Two***)*, we ask residents whether water conservation is a problem for others, their neighborhood, and their own household. A personalized account system can help to show each household’s role in water conservation.

Localizing the Impact, Changing Social Norms: effectiveness. Our team analyzed the impact of this bolder, more difficult-to-measure alternative. Although we expect such measures to have a small effective on per capita and aggregate water use in the short term, we think it might be helpful to project 5-year rates of effectiveness as SCVWD considers new long-term initiatives. Though new activities like personal accounts or education programs might be expensive, as marginal returns begin to diminish traditional water use savings from the *stats-quo* and from the first alternative, such programs might become advisable. We expect that the social norms alternative has little positive effect (and perhaps negative impact) on cost-effectiveness, and little to no effect on scale, the aggregate water use measure. Yet when it comes to *impact*, the per capita water use criterion, our team hopes to see long-term water savings that justify consideration of these programs.

How our Recommendations Affect Cost-Effectiveness, Impact, and Scale

Ultimately, our team considered our two alternatives in light of the 3 criteria proposed: cost-effectiveness, impact, and scale. As the chart on the following pages illustrates, our team found conclusively that these two recommendations improve all three categories, each for specific reasons.

Expanding the tent helps make programs cost-effective by creating more economies of scale for water retailers. Rebate programs become more cost-effective as customers around SCVWD purchase new showerheads and new equipment. By expanding to new demographics, SCVWD can reach customers with the "low hanging fruit" of large water savings at a comparatively low cost. Reaching new customers will consequently increase total savings and thus cost-efficiency, particularly for programs with lower participation numbers, such as ITAP, CII Pre-Rinse Sprayers, Residential HE Toilets, CII Clothes Washers, and CII HE Toiles. Expanding the tent implicitly increases program impact, as more SCC residents join these programs and boost participation numbers. These participation rates also mean that the *proportion* of households also increases. As such, the potential for scaling up programs is limited as retailers reach a larger and larger share of the full County population.

Changing social norms does not lead to cost-effectiveness for *rebate* programs specifically, but does create more organic savings. In fact, programs like the "Water Wise House Calls" will see large savings in water at a comparatively low cost. Changing social norms connotes education and active water use change by residents, but also connotes a greater awareness around rebate and other programs. Therefore, economies of scale and greater participation may also occur. Regarding impact, figures should increase in impact across the board as customers help create more *water savings* through new behaviors around water use. In this area, we believe SCVWD is already doing a great job with their "Brown is the New Green" awareness campaigns and educational initiatives. For SCVWD to have an even greater impact though, we believe an automated water meter system that provides households with personal reports will further help individuals become more cognizant of their own water use habits. Finally, as social norms change around water use, our team expects the number of households reached to increase. At the same time, we expect the proportion of the population reached to increase and the program’s expansion potential to decrease.

Table 12: Comparative analysis of the status quo, "expand the tent," and changing social norms. Integrative analysis of Chapter 5 and 6.

	Status-Quo	*New Proposal #1: Expand the Tent*	*New Proposal #2: Changing Social Norms and Long-Term Water Usage*
Cost-effectiveness – Total Savings / Total Costs (AF/$)	**Residential LF Showerhead, SF – Most Effective Program with .0264. Rank = 1.** **Residential Turf is least cost-effective, with .00011. Rank = 10.**	**Cost-effectiveness *improves* greatly as more new SCC citizens participate in the program, thereby creating program economies of scale and more Total Savings.**	**More individuals participate in rebate programs when social norms create a "community of expectations" around water use. Cost-effectiveness numbers themselves *do not change***
Impact – (Total Savings * Total Participation) / Years of Data (AF/$)	**Residential Cloths Washers has the highest Impact with 2102478368. Rank = 1.** **Residential Turf also has the lowest impact (349,127); Rank = 10.**	**Impact *improves* greatly with participation rates as programs target new demographics and portions of Santa Clara County, and as SCVWD help retailers focus on specific populations.**	**Impact will *improve* as more water is saved by the customer, not just the retailer, through efficient active and educational programs. Higher savings rates lead to a larger impact.**
Scale – Participation / Number of Household (%)	**High Efficiency Toilet has the most potential; current impact is 2.55%. Rank = 1.** **Residential Clothes Washers has the *highest current* scale; 25.52%; Rank = 9.**	**All programs *scale up* as a result of new users joining water conservation efforts. Participation rates increase across all programs.**	**As social norms change around water use, the number of households reached will increase. Proportion of the population reached will *increase*; potential to expand will decrease**

8. CONCLUSION

Water in Santa Clara County, and indeed in all of California's integrated water system, is scarce. Facing growing population and increasingly dire drought, Santa Clara Valley Water District must turn to conservation and efficiency programs to play a central role in effectively meeting future water demand.

Our team examined the factors that might lead to greater water conservation and efficiency in the Santa Clara Valley Water District (SCVWD). We began by providing demographic context to the District. Next, our team examined program participation by retailer; SCVWD operates as a water wholesaler and solely provides water for 12 independently run water retailers that interact directly with consumers. Our team found promise in small retailers and specific programs. Finally, we compared SCVWD's efforts with those of two other peer water districts. We focused this best practices analysis on automated water meter programs.

In our primary analysis, our team developed the core criteria of cost-effectiveness, impact, and scale. By this metric, our team critically compared different programs and their implementation across SCVWD. Our team considered and scored each of the top district programs according to each criteria, and arrived at an ultimate result based off of a direct average of the three criteria. Lastly, our team considered potential alternative interventions to increase water savings (or to improve water conversation and efficiency more generally) and recommends an "Expand the Tent" approach and a strategy to "Change Social Norms" which might create a community of expectations around careful water use. Both of these recommendations, our team argues, can help improve cost-effectiveness, impact, and scale.

In the midst of one of California's most severe droughts, it is easy to become cynical about water use and finding solutions to actively engage district customers. Yet our team found specific and actionable programs that work *well* to save water and can expand to reach more members of the Santa Clara County population. Moreover, technological innovations continue to improve, allowing for the potential of more water savings than previously imagined. We hope our recommendations can help reduce water use in Santa Clara Valley Water District, and do so in a cost-effective, high-impact, and scalable way.

9. APPENDIX

Appendix One. Survey Instrument for determining more nuanced rates of water usage across Santa Clara Valley Water District. This instrument is available at the end of this report.

Appendix Two. San Francisco Public Utilities Commission's Retail Water Conservation Plan.

Appendix Three. Reference to the 2004 report prepared by M. Cube for the water district, and our team's synthesis of the report's major takeaways and recommendations and thoughts on how we have incorporated its conclusions.

Appendix Four. Link to our own master data spreadsheet of all SCVWD retailer information and a manifest table of information about each program.

Appendix Five. Link to Santa Clara Valley Water District's Water Savings both longitudinally and by program. These data are used as our primary tool for the cost-effectiveness metric.

Appendix Six. Demographic data and indicators for Santa Clara County, and for specific municipalities within the County.

Appendix Seven. Additional references provided by Santa Clara Valley Water District.

Appendix One. Survey Instrument to determine cross-county water usage

Water Questionnaire Draft

Executive Summary of Survey and General View Outline:

1. Drought seriousness questions
2. General conservation questions
3. Specific conservation questions
    1. [Description]. Have you heard of the following program?
        1. If yes:
            1. How?
            2. Did you participate?
            3. How satisfied were you?
            4. Do you feel you saved money?
            5. Do you feel you made a difference?
            6. How likely are you to participate in another program?
                1. Why?

If no:

1. How likely are you to participate?
    2. Why?

Demographics Questions

Drought Seriousness Questions:

[INTRO PAGE]
[Text Screen]
Thank you for your participation in this Stanford University research study.

In this survey, we will ask you a variety of questions regarding water conservation efforts. This is an independent study; we do not represent the views of any water district or outside organization.

Participation in this survey is voluntary and responses are anonymous.

[New Screen]
[Radio Button]
Q1. As far as you know, would you say that California is currently in a drought or that California is not currently in a drought?

1. Currently in a drought
2. Not currently in a drought

[SPLIT INTO SUBSAMPLE X AND SUBSAMPLE Y]

[ASK SUBSAMPLE X]
[RANDOMIZE QUESTION ORDER OF 2Ax, 2Bx, 2Cx, 2Dx, 2Ex]

[New Screen]
[Text Screen]
California is currently facing one of the most severe droughts on record. Governor Brown declared a drought State of Emergency in January and directed state officials to take all necessary actions to prepare for water shortages. 2014 was officially the driest year on record since 1977. Some towns are literally running out of water. Residents are being asked to conserve water, and agriculture has already been severely impacted.

[New Screen]
[Radio Button]
Q2Ax. How serious of a problem do you think the drought will be for the economy?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Bx. How serious of a problem do you think the drought will be for California?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Cx. How serious of a problem do you think the drought will be for your city?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Dx. How serious of a problem do you think the drought will be for your household?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Ex. How serious of a problem do you think the drought will be for you personally?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Fx. How serious of a problem do you think the drought will be in the short-run?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Gx. How serious of a problem do you think the drought will be in the long-run?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Hx. How important do you think it is for your state officials to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[New Screen]
[Radio Button]
Q2Ix. How important do you think it is for your water district to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[New Screen]
[Radio Button]
Q2Jx. How important do you think it is for you personally to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[ASK SUBSAMPLE Y]
[RANDOMIZE QUESTION ORDER OF 2Ay, 2By, 2Cy, 2Dy, 2Ey]

[New Screen]
[Radio Button]
Q2Ay. If California were currently in a drought, how serious of a problem do you think the drought would be for the economy?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2By. If California were currently in a drought, how serious of a problem do you think the drought would be for California?

1. Extremely serious
2. Very serious
3. Somewhat serious

4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Cy. If California were currently in a drought, how serious of a problem do you think the drought would be for your city?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Dy. If California were currently in a drought, how serious of a problem do you think the drought would be for your household?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Ey. If California were currently in a drought, how serious of a problem do you think the drought would be for you personally?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Fy. If California were currently in a drought, how serious of a problem do you think the drought would be in the short-run?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Gy. If California were currently in a drought, how serious of a problem do you think the drought would be in the long-run?

1. Extremely serious
2. Very serious
3. Somewhat serious
4. Not very serious
5. Not serious at all

[New Screen]
[Radio Button]
Q2Hy. If California were currently in a drought, how important do you think it would be for your state officials to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[New Screen]
[Radio Button]
Q2Iy. If California were currently in a drought, how important do you think it would be for your water district to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[New Screen]
[Radio Button]
Q2Jy. If California were currently in a drought, how important do you think it would be for you personally to immediately begin taking water conservation efforts?

1. Extremely important
2. Very important
3. Somewhat important
4. Not very important
5. Not important at all

[New Screen]

[Text Screen]
California is currently facing one of the most severe droughts on record. Governor Brown declared a drought State of Emergency in January and directed state officials to take all necessary actions to prepare for water shortages. 2014 was officially the driest year on record since 1977.

General Conservation Questions:

[ASK ALL]
[New Screen]
[Radio Button]
Q10. How likely are you to reduce the amount of water you use because of the drought?

1. Extremely likely
2. Very likely
3. Somewhat likely
4. Not very likely
5. Not likely at all

[New Screen]
[Radio Button]
Q11. Are you or your family taking any measures to combat the drought? [Mark all that apply]

1. Taking shorter showers
2. Not watering or xeriscaping the lawn
3. Upgrading to dual-flush toilets
4. Using greywater
5. No
6. Other [Please specify]

[New Screen]
[Radio Button]
Q12. As far as you know, are your neighbors or friends taking any measures to combat the drought? [Mark all that apply]

1. Taking shorter showers
2. Not watering or xeriscaping the lawn
3. Upgrading to dual-flush toilets
4. Using greywater
5. No
6. I’m not sure
7. Other [Please specify]

[New Screen]

[Radio Button]
Q13. Do you know of any water conservation programs in the area?

1. Yes
2. No

Specific Conservation Questions:

[What programs are there? We should highlight either the current most popular or seemingly most efficient programs. Is this only for homeowners?!]

Ex. REBATE PROGRAM DESCRIPTION

How likely are you to participate in this program?

If X would save you money, would you participate?
If X would save you XX amount of water, would you participate?
If the rebate was $X, would you participate?
If the rebate was $XX would you participate?
What are the biggest obstacles? (CHECK ALL THAT APPLY) OR
What are the biggest obstacles? (TEXT BOX)

[New Screen]
[Ask if 5=**YES**]
5a. Which water conservation program(s) have you heard of? [check all that apply]

- Rebate programs (for example for washing machines)
- School education and outreach initiatives
- Santa Clara Valley Water District programs
- Passive efforts to upgrade piping and water infrastructure
- Efforts to change water policy
- Other [insert name of program]

[New Screen]
[Ask for each selection in 5a]
5b. How did you hear about the area's water conservation programs?

- TV advertising
- Internet
- Print mailer
- Friends /word-of-mouth
- Billboard
- I saw it on my water bill
- Other: please specify

6. Have you ever participated in ANY Santa Clara Valley Water District (SCVWD) program?
[Ask if 5=**NO**]

  - Why not? (Check all that apply)
    - I did not know about these programs

        - These programs are not cost effective
        - Do not believe in these programs

    - What is preventing you from participating? (Check all that apply)
        - Waste of time
        - Not efficient
        - Won't save water
        - Won't save me money
        - Others are not participating
        - Saving water is not my problem
        - I do not see the benefit to participating

    - Now that you know more about the fact that pro-active water conservation programs that might affect you, such as rebates and education initiatives, are you more likely to participate in them?
        - Much more likely
        - More likely
        - No more likely
        - Less likely

7. Have you ever participated in any SCVWD program? **[if yes]**
    - Follow up questions
        - Did you have enough information about the program?
            - Yes
            - No

Do you feel that you / the program made a difference?
- Yes
- No

Have you participated in *multiple* programs?
- Yes
- No

Would you ever consider participating in *another* program?
- Yes
- No

Do you think you saved money?
- Yes
- No

Do you think you helped with conserving water?
- Yes
- No

Do you know of others who participated in the program?
- Yes
- No

8. Are you interested in learning more about SCVWD services or programs?
    - Yes

- No

Link them to site / provide web address?

Demographics Questions:

The following questions are for classification purposes only. Your answers will be aggregated with those of other participants to this survey.

D1. What is your registered political affiliation?

1 Democrat
2 Republican
3 Independent
4 Other
5 Not registered

D1a. What would you say is your political ideology?

1 Very liberal
2 Liberal
3 Moderate
4 Conservative
5 Very conservative

D2. What is your gender?

1 Male
2 Female
3 Other

D3. What is your marital status?

1 Married
2 Widowed
3 Divorced
4 Separated
5 Never married

D4. What is the highest level of education you have completed?

1 Some high school
2 High school graduate
3 Some college
4 Trade/technical/vocational training
5 College graduate
6 Some graduate school
7 Graduate degree

D5. What is your age?

________ (RECORD NUMBER: 18-99)

[ASK IF D5=SKIPPED]
D5a. Please choose your age range.

1 18 to 29
2 30 to 44
3 45 to 64
4 65 or older

D6. Are you Hispanic or Latino?

1 Yes
2 No

[Multiple Answers Accepted]
D7. Please choose one or more races that you consider yourself to be:

1 White
2 Black or African American
3 American Indian or Alaska Native
4 Asian
5 Native Hawaiian or Other Pacific Islander
6 Mixed race or multi-racial
7 Another race

D8. Including yourself, how many adults live in your household?

_______ (Validation: At least 1)

D9. Are you the parent or guardian of one or more children under the age of 18?

1 Yes
2 No

D9a. Are you the parent or guardian of any children who are age 18 or older?

1 Yes
2 No

D10. Which of the following categories best describes your total household income in 2014, before taxes, from all sources?

1 Under $20,000 a year
2 $20,000 - $35,000 a year

3 $35,000 - $50,000 a year
3 $50,000 - $75,000 a year
5 $75,000 - $100,000 a year
6 $100,000 - $150,000 a year
7 $150,000 - $200,000 a year
8 More than $200,000 a year

[Multiple Answers Accepted]
D11. Are you now employed full-time, part-time, not employed, or retired??

1 Full-time
2 Part-time
3 Not employed
4 Retired

D12. In which industry or sector of the economy do you work?

1 Agriculture
2 Service sector
3 Industrial / manufacturing sector
4 Professional / education sector
5 Other [Please specify]

D13. Describe your home?

1 Condo / apartment
2 Single-family home
3 Mobile home / trailer
4 Other [Please specify]

D14. What is your five digit zip code at your home?

1 Zip code ______

Social Explorer - ACS 2013 (5-Year Estimates)

Statistics	**Santa Clara County, California**		**Mountain View city; San Jose-Sunnyvale-Santa Clara, San Jose-Sunnyvale-Santa Clara, California**		**Palo Alto city; San Jose-Sunnyvale-Santa Clara, San Jose-Sunnyvale-Santa Clara, California**		**San Jose city; San Jose-Sunnyvale-Santa Clara, San Jose-Sunnyvale-Santa Clara, California**		**Santa Clara city; San Jose-Sunnyvale-Santa Clara, San Jose-Sunnyvale-Santa Clara, California**		**Sunnyvale city; San Jose-Sunnyvale-Santa Clara, San Jose-Sunnyvale-Santa Clara, California**		**TOTAL (All Selected Principal Cities)**	
SE:T1. Total Population														
Total Population	1,812,208		75,477		65,234		968,903		117,817		143,315		1,370,746	
SE:T7. Age														
Total Population:	1,812,208		75,477		65,234		968,903		117,817		143,315		1,370,746	
Under 5 Years	123,460	6.8%	5,147	6.8%	3,358	5.2%	67,640	7.0%	9,460	8.0%	11,974	8.4%	97,579	7.1%
5 to 9 Years	125,576	6.9%	4,728	6.3%	4,352	6.7%	69,209	7.1%	7,740	6.6%	8,495	5.9%	94,524	6.9%
10 to 14 Years	113,788	6.3%	3,436	4.6%	4,864	7.5%	62,027	6.4%	6,092	5.2%	7,349	5.1%	83,768	6.1%
15 to 17 Years	68,961	3.8%	2,026	2.7%	2,619	4.0%	37,184	3.8%	3,454	2.9%	4,224	3.0%	49,507	3.6%
18 to 24 Years	160,218	8.8%	5,203	6.9%	3,675	5.6%	91,195	9.4%	12,538	10.6%	9,745	6.8%	122,356	8.9%
25 to 34 Years	273,779	15.1%	15,694	20.8%	8,428	12.9%	148,228	15.3%	21,254	18.0%	29,286	20.4%	222,890	16.3%
35 to 44 Years	279,970	15.5%	13,414	17.8%	8,929	13.7%	150,888	15.6%	20,306	17.2%	22,435	15.7%	215,972	15.8%
45 to 54 Years	265,822	14.7%	10,003	13.3%	10,140	15.5%	138,773	14.3%	15,230	12.9%	19,689	13.7%	193,835	14.1%
55 to 64 Years	194,102	10.7%	7,758	10.3%	7,834	12.0%	101,385	10.5%	10,385	8.8%	13,999	9.8%	141,361	10.3%
65 to 74 Years	112,625	6.2%	4,411	5.8%	5,617	8.6%	57,193	5.9%	5,562	4.7%	8,563	6.0%	81,346	5.9%
75 to 84 Years	65,462	3.6%	2,470	3.3%	3,355	5.1%	32,148	3.3%	4,137	3.5%	5,266	3.7%	47,376	3.5%
85 Years and over	28,445	1.6%	1,187	1.6%	2,063	3.2%	13,033	1.4%	1,659	1.4%	2,290	1.6%	20,232	1.5%
SE:T13. Race														

Total Population:	1,812,208		75,477		65,234		968,903		117,817		143,315		1,370,746	
White Alone	900,332	49.7%	45,626	60.5%	42,468	65.1%	445,070	45.9%	54,684	46.4%	65,443	45.7%	653,291	47.7%
Black or African American Alone	47,869	2.6%	1,355	1.8%	1,756	2.7%	30,401	3.1%	4,251	3.6%	2,915	2.0%	40,678	3.0%
American Indian and Alaska Native Alone	9,634	0.5%	157	0.2%	60	0.1%	6,153	0.6%	556	0.5%	332	0.2%	7,258	0.5%
Asian Alone	589,931	32.6%	20,505	27.2%	16,889	25.9%	317,821	32.8%	44,656	37.9%	59,971	41.9%	459,842	33.6%
Native Hawaiian and Other Pacific Islander Alone	6,317	0.4%	218	0.3%	36	0.1%	3,187	0.3%	351	0.3%	1,029	0.7%	4,821	0.4%
Some Other Race Alone	175,044	9.7%	4,014	5.3%	1,252	1.9%	120,039	12.4%	7,959	6.8%	7,882	5.5%	141,146	10.3%
Two or More races	83,081	4.6%	3,602	4.8%	2,773	4.3%	46,232	4.8%	5,360	4.6%	5,743	4.0%	63,710	4.7%
SE:T14. Hispanic Or Latino By Race														
Total Population	1,812,208		75,477		65,234		968,903		117,817		143,315		1,370,746	
Not Hispanic or Latino:	1,326,615	73.2%	59,771	79.2%	60,037	92.0%	647,353	66.8%	94,361	80.1%	117,370	81.9%	978,892	71.4%
White Alone	628,410	34.7%	34,811	46.1%	38,692	59.3%	270,936	28.0%	41,165	34.9%	48,570	33.9%	434,174	31.7%
Black or African American Alone	43,760	2.4%	1,311	1.7%	1,677	2.6%	27,258	2.8%	4,119	3.5%	2,701	1.9%	37,066	2.7%
American Indian and Alaska Native Alone	4,014	0.2%	91	0.1%	43	0.1%	1,920	0.2%	480	0.4%	184	0.1%	2,718	0.2%
Asian Alone	585,369	32.3%	20,443	27.1%	16,812	25.8%	314,834	32.5%	44,148	37.5%	59,712	41.7%	455,949	33.3%
Native Hawaiian and Other Pacific Islander Alone	5,975	0.3%	159	0.2%	36	0.1%	3,056	0.3%	336	0.3%	1,005	0.7%	4,592	0.3%
Some Other Race Alone	3,804	0.2%	66	0.1%	262	0.4%	1,333	0.1%	318	0.3%	738	0.5%	2,717	0.2%
Two or More races	55,283	3.1%	2,890	3.8%	2,515	3.9%	28,016	2.9%	3,795	3.2%	4,460	3.1%	41,676	3.0%
Hispanic or Latino:	485,593	26.8%	15,706	20.8%	5,197	8.0%	321,550	33.2%	23,456	19.9%	25,945	18.1%	391,854	28.6%
White Alone	271,922	15.0%	10,815	14.3%	3,776	5.8%	174,134	18.0%	13,519	11.5%	16,873	11.8%	219,117	16.0%
Black or African American Alone	4,109	0.2%	44	0.1%	79	0.1%	3,143	0.3%	132	0.1%	214	0.2%	3,612	0.3%
American Indian and Alaska Native Alone	5,620	0.3%	66	0.1%	17	0.0%	4,233	0.4%	76	0.1%	148	0.1%	4,540	0.3%
Asian Alone	4,562	0.3%	62	0.1%	77	0.1%	2,987	0.3%	508	0.4%	259	0.2%	3,893	0.3%

Native Hawaiian and Other Pacific Islander Alone	342	0.0%	59	0.1%	0	0.0%	131	0.0%	15	0.0%	24	0.0%	229	0.0%
Some Other Race Alone	171,240	9.5%	3,948	5.2%	990	1.5%	118,706	12.3%	7,641	6.5%	7,144	5.0%	138,429	10.1%
Two or More races	27,798	1.5%	712	0.9%	258	0.4%	18,216	1.9%	1,565	1.3%	1,283	0.9%	22,034	1.6%
SE:T21. Average Household Size														
Average Household Size	2.9		2.3		2.5		3.1		2.7		2.6		2.9	
SE:T25. Educational Attainment For Population 25 Years And Over														
Population 25 Years and over:	1,220,205		54,937		46,366		641,648		78,533		101,528		923,012	
Less Than High School	164,456	13.5%	4,733	8.6%	1,159	2.5%	113,579	17.7%	6,410	8.2%	9,457	9.3%	135,338	14.7%
High School Graduate (includes equivalency)	189,529	15.5%	5,884	10.7%	2,199	4.7%	117,319	18.3%	12,328	15.7%	11,776	11.6%	149,506	16.2%
Some college	298,934	24.5%	9,947	18.1%	5,992	12.9%	170,908	26.6%	19,272	24.5%	21,113	20.8%	227,232	24.6%
Bachelor's degree	314,485	25.8%	15,585	28.4%	13,252	28.6%	149,231	23.3%	22,459	28.6%	30,510	30.1%	231,037	25.0%
Master's degree	180,189	14.8%	12,610	23.0%	12,841	27.7%	67,950	10.6%	13,944	17.8%	21,920	21.6%	129,265	14.0%
Professional school degree	33,067	2.7%	2,304	4.2%	4,498	9.7%	11,151	1.7%	2,027	2.6%	2,084	2.1%	22,064	2.4%
Doctorate degree	39,545	3.2%	3,874	7.1%	6,425	13.9%	11,510	1.8%	2,093	2.7%	4,668	4.6%	28,570	3.1%
SE:T56. Household Income (In 2013 Inflation Adjusted Dollars)														
Households:	609,377		32,047		26,229		306,952		42,343		54,016		461,587	
Less than $10,000	23,716	3.9%	1,324	4.1%	987	3.8%	12,822	4.2%	1,711	4.0%	1,926	3.6%	18,770	4.1%
$10,000 to $14,999	19,238	3.2%	938	2.9%	683	2.6%	11,510	3.8%	1,220	2.9%	1,224	2.3%	15,575	3.4%
$15,000 to $19,999	18,252	3.0%	894	2.8%	615	2.3%	10,968	3.6%	1,224	2.9%	1,229	2.3%	14,930	3.2%
$20,000 to $24,999	19,423	3.2%	1,164	3.6%	557	2.1%	10,643	3.5%	1,249	3.0%	1,608	3.0%	15,221	3.3%
$25,000 to $29,999	19,389	3.2%	1,056	3.3%	561	2.1%	11,289	3.7%	1,649	3.9%	1,285	2.4%	15,840	3.4%
$30,000 to $34,999	17,766	2.9%	576	1.8%	632	2.4%	9,921	3.2%	1,061	2.5%	1,435	2.7%	13,625	3.0%
$35,000 to $39,999	16,360	2.7%	643	2.0%	428	1.6%	9,375	3.1%	1,220	2.9%	1,379	2.6%	13,045	2.8%

$40,000 to $44,999	19,541	3.2%	1,230	3.8%	553	2.1%	11,178	3.6%	1,371	3.2%	1,480	2.7%	15,812	3.4%
$45,000 to $49,999	17,216	2.8%	757	2.4%	701	2.7%	9,791	3.2%	1,204	2.8%	1,396	2.6%	13,849	3.0%
$50,000 to $59,999	34,898	5.7%	1,982	6.2%	1,041	4.0%	19,046	6.2%	2,856	6.7%	2,616	4.8%	27,541	6.0%
$60,000 to $74,999	48,185	7.9%	2,382	7.4%	1,810	6.9%	25,709	8.4%	3,247	7.7%	4,190	7.8%	37,338	8.1%
$75,000 to $99,999	73,513	12.1%	3,333	10.4%	2,312	8.8%	39,257	12.8%	4,841	11.4%	7,224	13.4%	56,967	12.3%
$100,000 to $124,999	65,080	10.7%	3,238	10.1%	2,513	9.6%	31,578	10.3%	5,775	13.6%	6,431	11.9%	49,535	10.7%
$125,000 to $149,999	49,989	8.2%	2,517	7.9%	1,656	6.3%	24,414	8.0%	3,825	9.0%	5,407	10.0%	37,819	8.2%
$150,000 to $199,999	68,757	11.3%	4,006	12.5%	2,923	11.1%	32,480	10.6%	4,662	11.0%	6,647	12.3%	50,718	11.0%
$200,000 or More	98,054	16.1%	6,007	18.7%	8,257	31.5%	36,971	12.0%	5,228	12.4%	8,539	15.8%	65,002	14.1%
SE:T113. Poverty Status In 2013 Of Families By Family Type By Presence Of Children Under 18 Years														
Families:	435,873		17,841		17,121		225,674		27,888		36,075		324,599	
Income in 2013 below poverty level:	30,253	6.9%	1,017	5.7%	714	4.2%	19,872	8.8%	1,555	5.6%	1,877	5.2%	25,035	7.7%
Married Couple Family: With Related Child Living Bellow Poverty Level	9,758	2.2%	258	1.5%	121	0.7%	6,678	3.0%	487	1.8%	629	1.7%	8,173	2.5%
Married Couple Family: No related children under 18 Years	5,132	1.2%	286	1.6%	249	1.5%	3,088	1.4%	235	0.8%	358	1.0%	4,216	1.3%
Male Householder, no wife present:	3,361	0.8%	50	0.3%	38	0.2%	2,423	1.1%	137	0.5%	331	0.9%	2,979	0.9%
With related children under 18 Years	2,637	0.6%	50	0.3%	0	0.0%	1,936	0.9%	130	0.5%	248	0.7%	2,364	0.7%
No related children under 18 Years	724	0.2%	0	0.0%	38	0.2%	487	0.2%	7	0.0%	83	0.2%	615	0.2%
Female Householder, no husband present:	12,002	2.8%	423	2.4%	306	1.8%	7,683	3.4%	696	2.5%	559	1.6%	9,667	3.0%
With related children under 18 Years	9,959	2.3%	326	1.8%	306	1.8%	6,291	2.8%	603	2.2%	492	1.4%	8,018	2.5%
No related children under 18 Years	2,043	0.5%	97	0.5%	0	0.0%	1,392	0.6%	93	0.3%	67	0.2%	1,649	0.5%
Income in 2013 at or above	405,620	93.1	16,82	94.3	16,40	95.8	205,80	91.2	26,333	94.4	34,198	94.8	299,564	92.3

poverty level	%	4 %	7 %	2 %	%	%	%

Note:
For data sources, citations and notes please take a look at sheet in this workbook titled 'Sources & Notes.'

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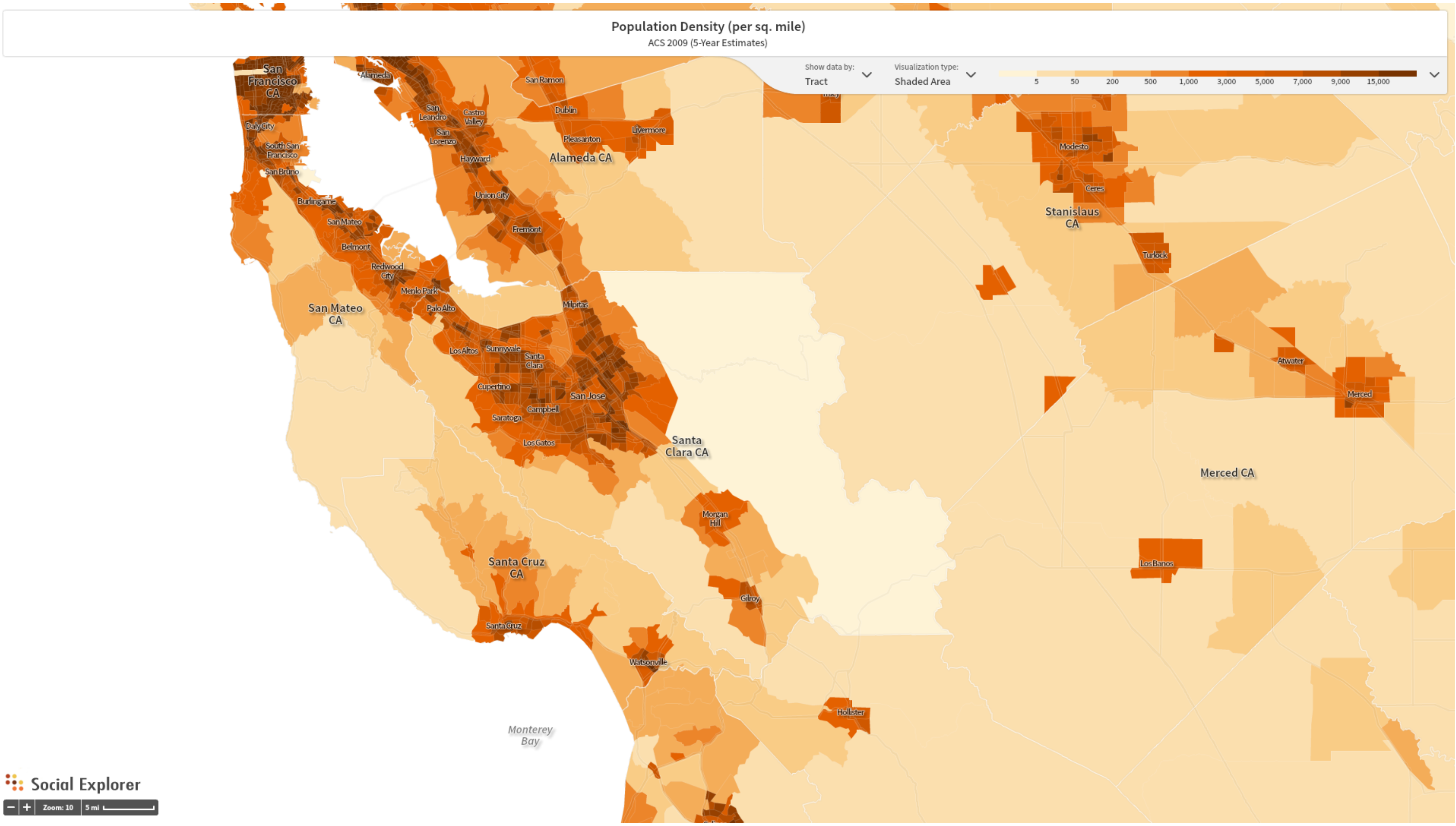
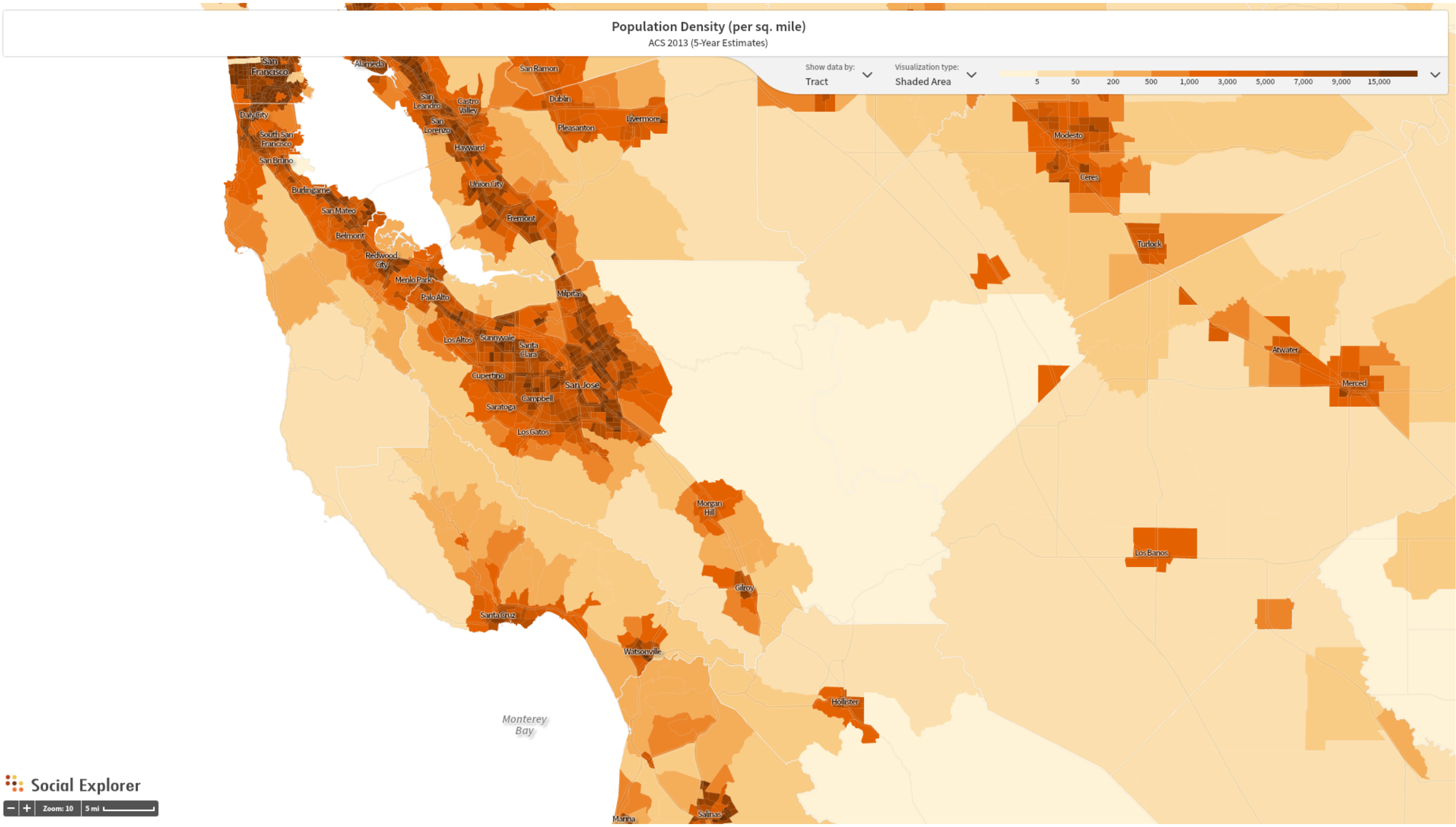


Population Density (per sq. mile)

ACS 2009 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area



Population Density (per sq. mile)

ACS 2013 (5-Year Estimates)

Show data by: Tract

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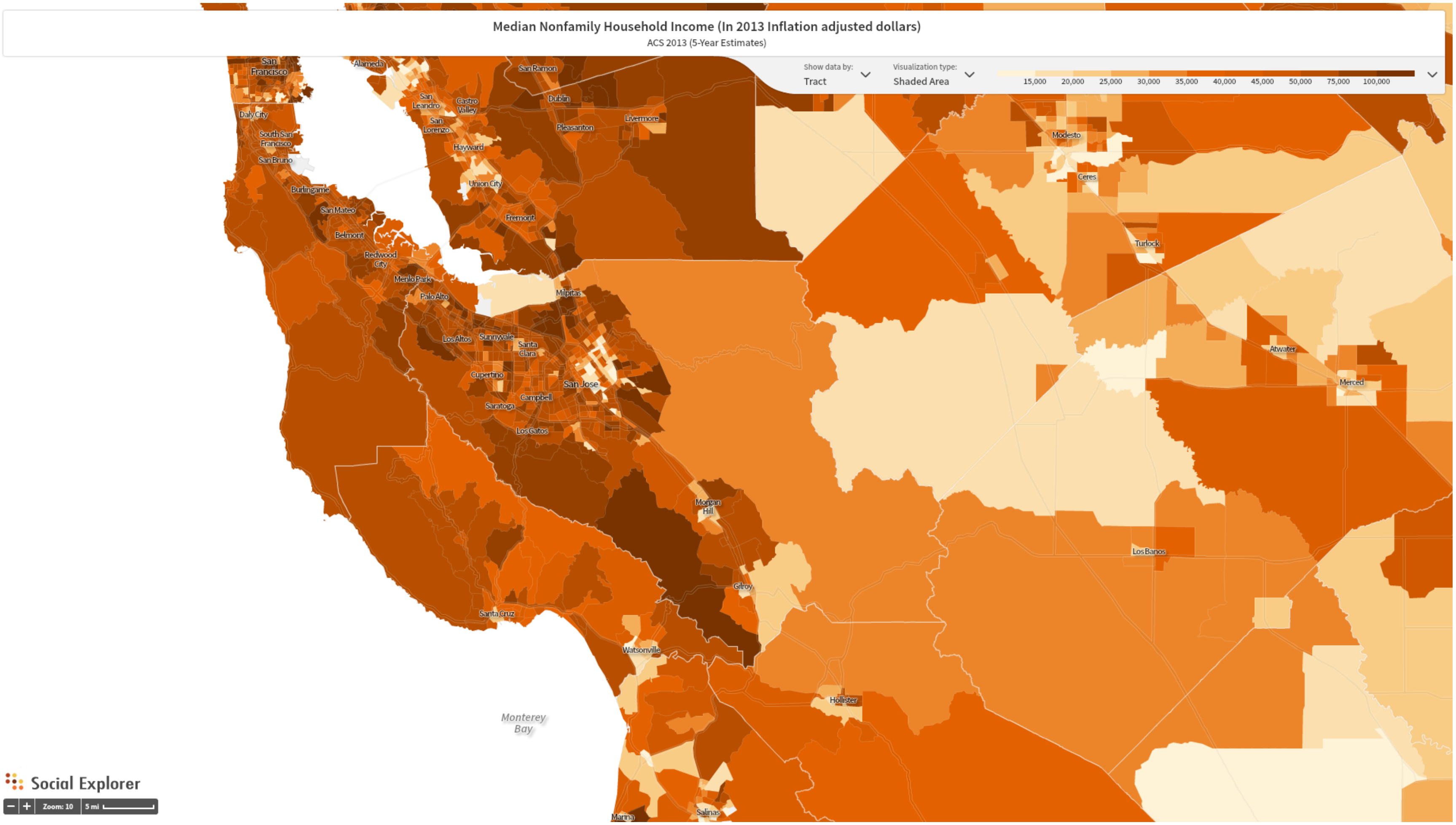
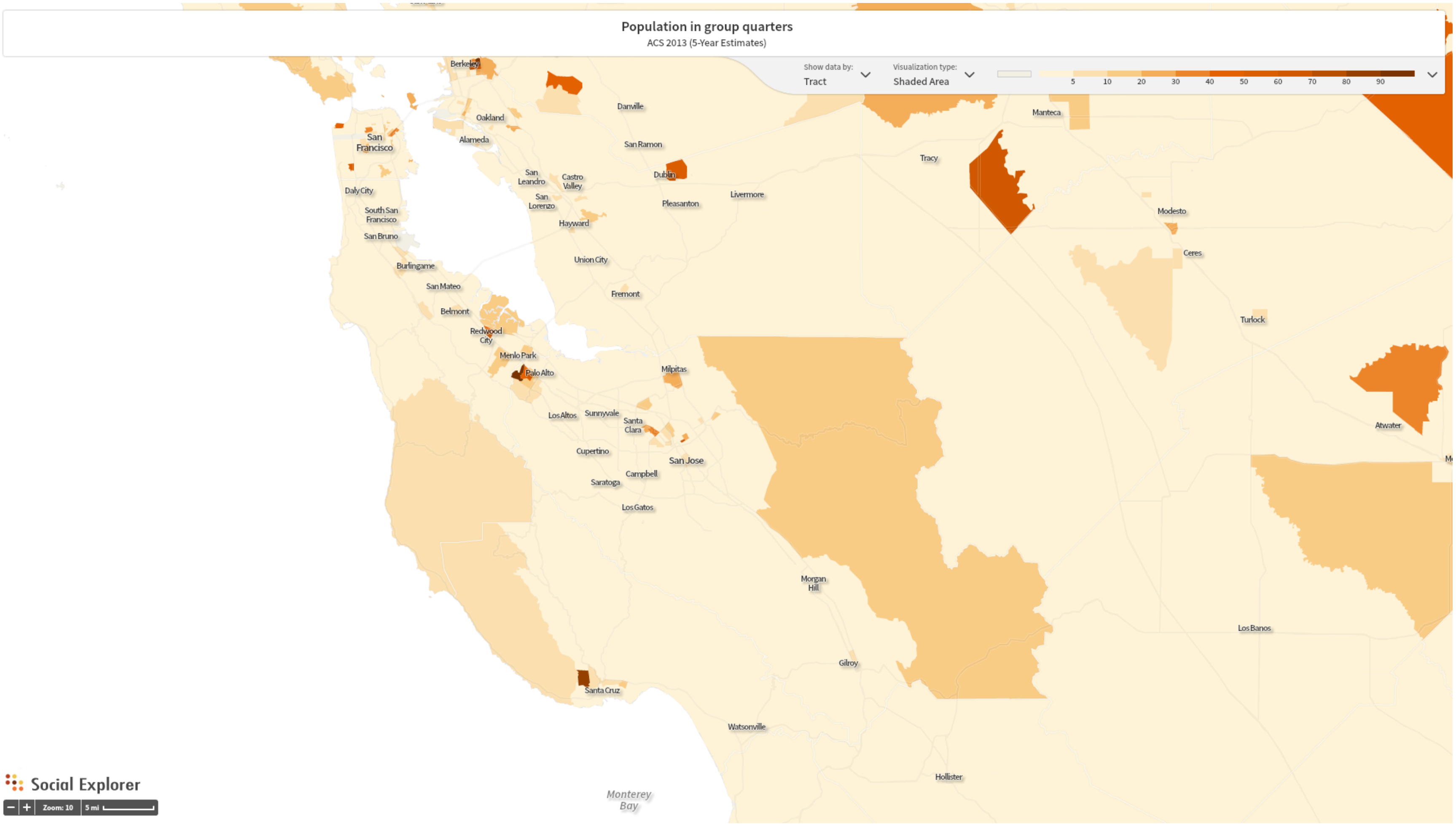


Median Nonfamily Household Income (In 2013 Inflation adjusted dollars)

ACS 2013 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area

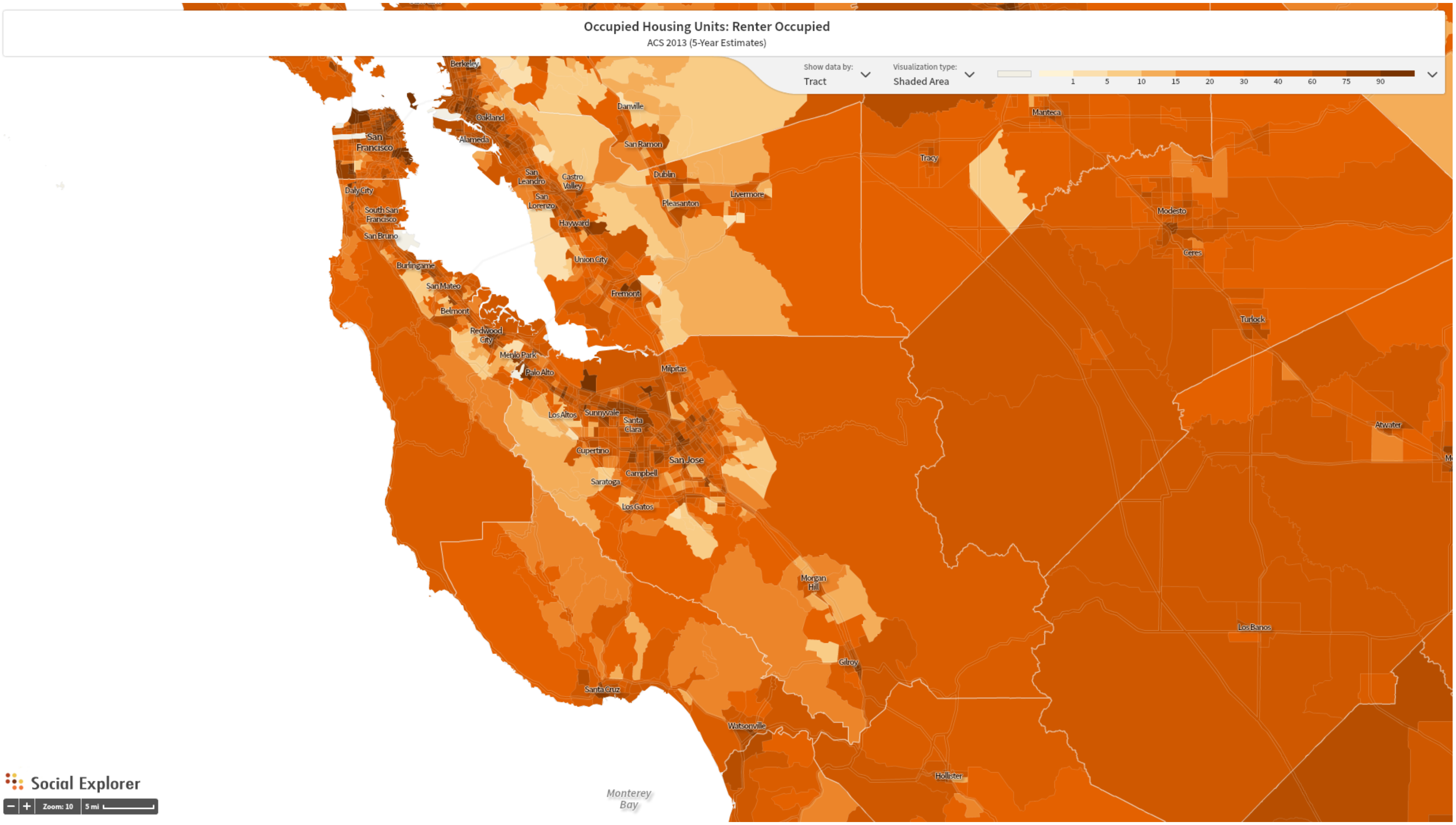


Population in group quarters

ACS 2013 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area

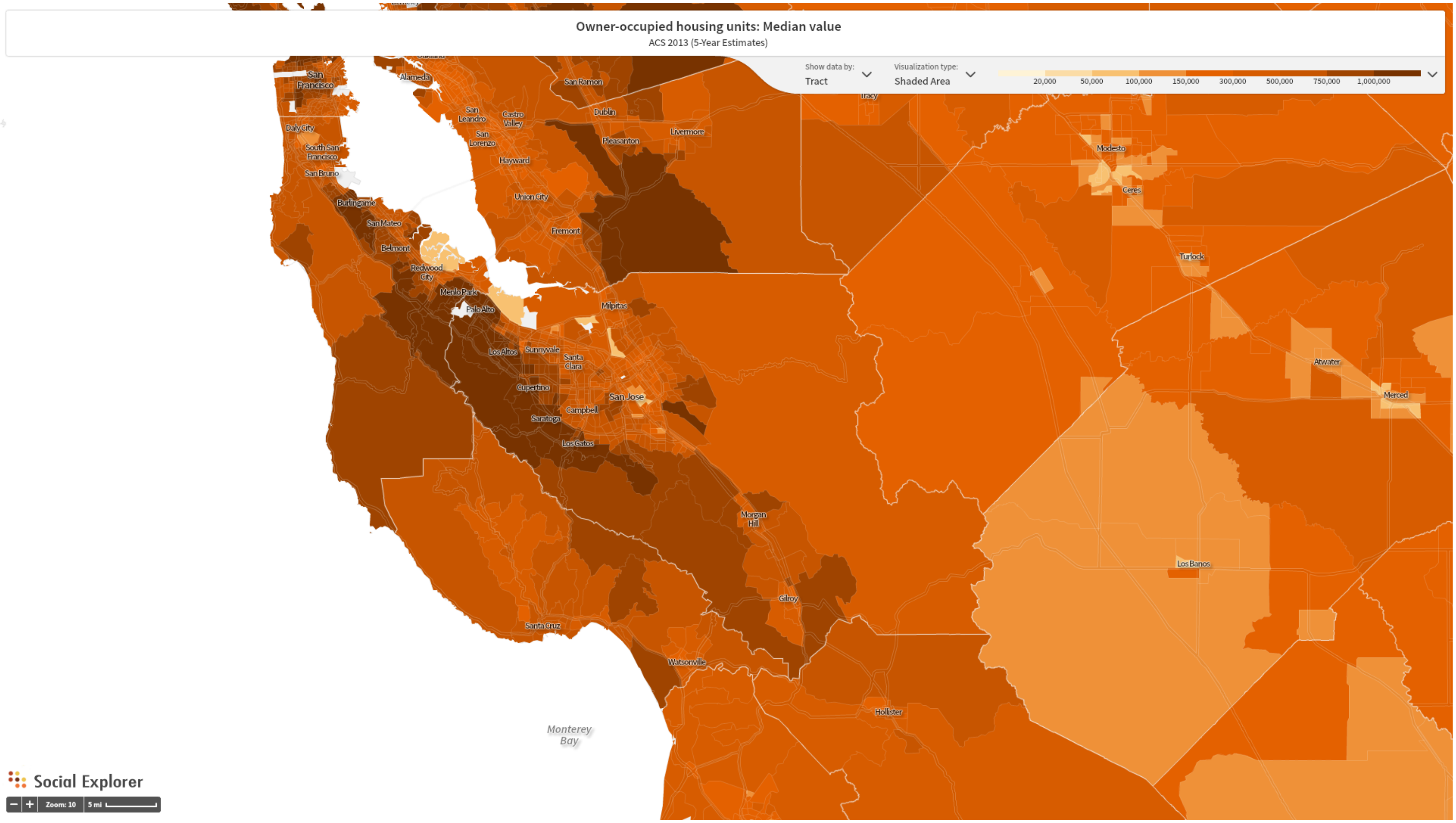


Occupied Housing Units: Renter Occupied

ACS 2013 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area

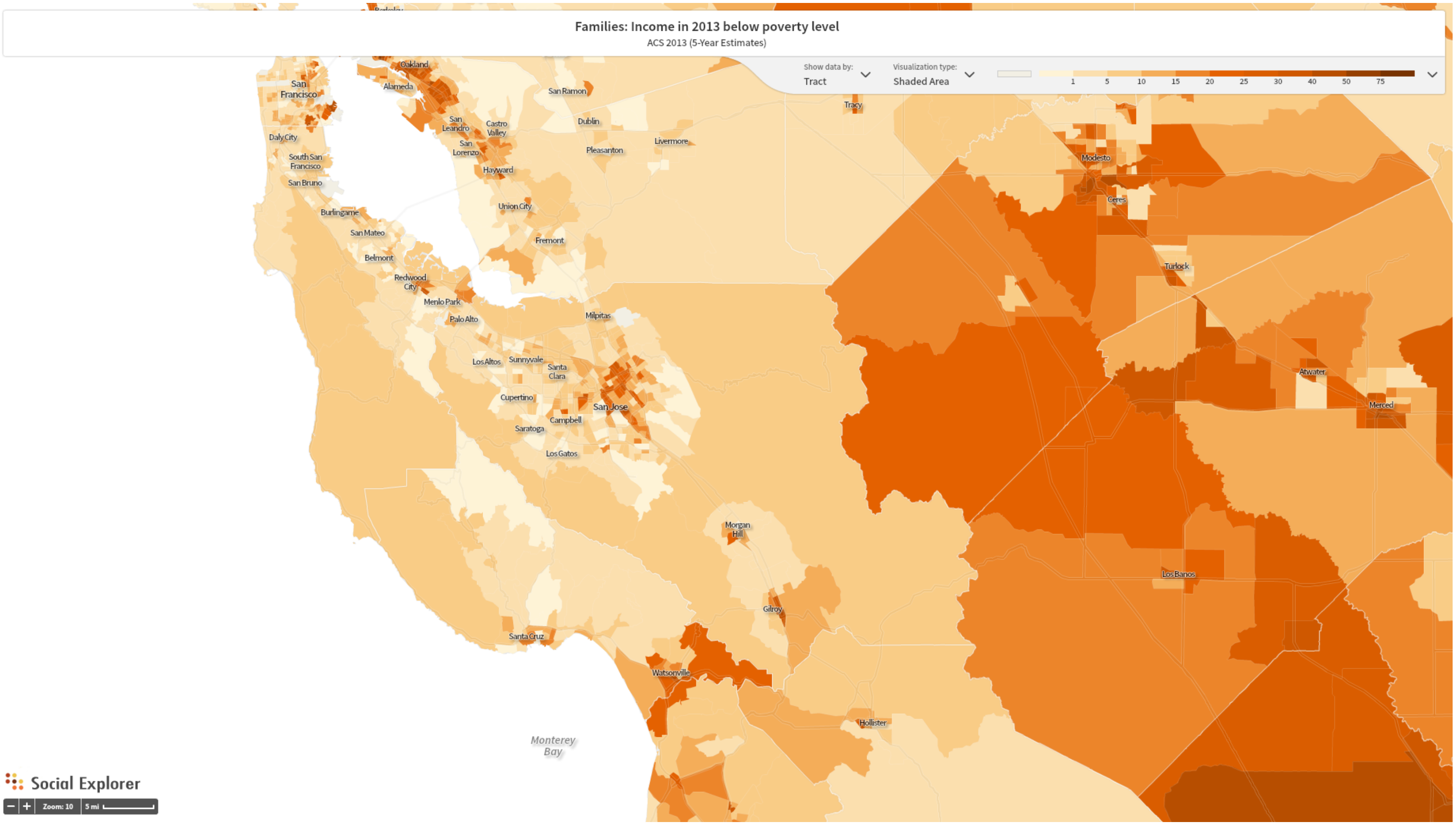


Owner-occupied housing units: Median value

ACS 2013 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area

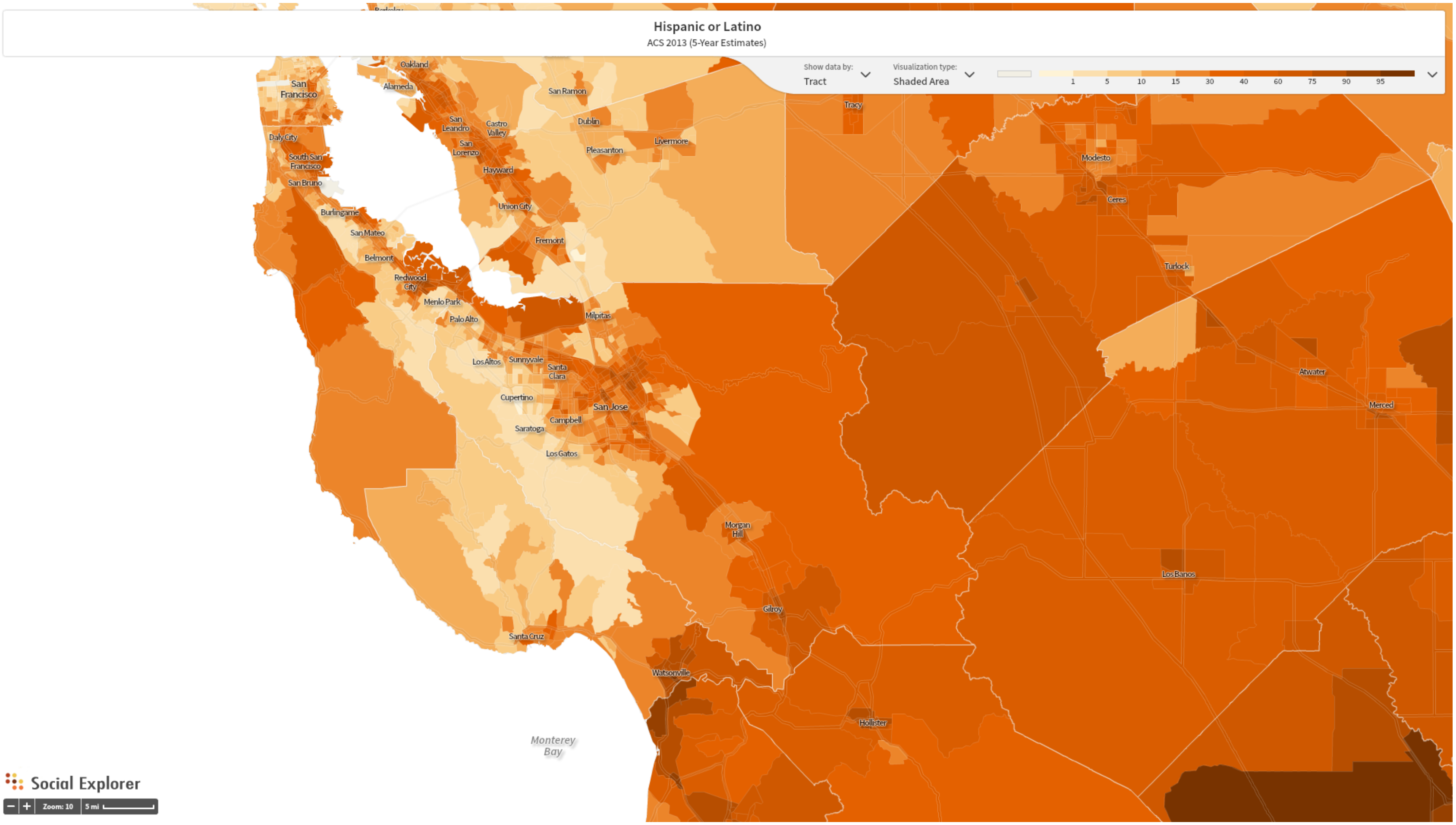


Families: Income in 2013 below poverty level

ACS 2013 (5-Year Estimates)

Show data by: Tract

Visualization type: Shaded Area

Hispanic or Latino
ACS 2013 (5-Year Estimates)
Show data by:
Tract
Visualization type:
Shaded Area
1
5
10
15
30
40
60
75
90
95
San Francisco
Oakland
Alameda
San Ramon
San Leandro
Castro Valley
Dublin
San Lorenzo
Pleasanton
Livermore
Tracy
Daly City
South San Francisco
San Bruno
Hayward
Union City
Modesto
Ceres
Burlingame
San Mateo
Fremont
Belmont
Redwood City
Turlock
Menlo Park
Palo Alto
Milpitas
Los Altos
Sunnyvale
Santa Clara
Atwater
Cupertino
San Jose
Merced
Campbell
Saratoga
Los Gatos
Morgan Hill
Los Banos
Gilroy
Santa Cruz
Watsonville
Hollister
Monterey Bay
Social Explorer
Zoom: 10
5 mi

Appendix Seven. Additional references provided by Santa Clara Valley Water District

BMP Cost Savings Study report that defines active versus passive water savings:
http://www.doe2.com/download/Water-Energy/CUWCC_BMPCostsSavingsStudy.pdf

Inland Empire Utilities Agency's Business Plan:
http://www.water.ca.gov/urbanwatermanagement/2010uwmps/Inland%20Empire%20Utilities%20Agency/Appendix%20L%20-%20IEUA%20Water%20Use%20Efficiency%20Business%20Plan.pdf

Informative websites:

1. http://www.allianceforwaterefficiency.org/
2. http://www.cuwcc.org/

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